United States
Department of
Agriculture

Forest Service

**Pacific
Northwest
Region**

R6-Ecol-TP-004-88

1988

Plant Association and Management Guide for the Ponderosa Pine, Douglas-fir, and Grand Fir Zones

Mt. Hood National Forest

Cover Photograph

View of Mount Hood as seen from Mill Creek Ridge within the Mill Creek Research Natural Area on the eastern edge of the Mt. Hood National Forest. Foreground sites include some ponderosa pine association communities adjacent to the meadow which was a heavily grazed sheep drive trail during the early 1900's. The background forests include a narrow band of Douglas-fir series associations below the wide expanse of grand fir series vegetation which blankets most of the Barlow Ranger District from 2500-4500 feet in elevation. Photo by Chris Topik.

United States
Department of
Agriculture

Forest Service

**Pacific
Northwest
Region**

R6-ECOL-TP-004-88
October 1988

Plant Association and Management Guide for the Ponderosa Pine, Douglas-fir, and Grand Fir Zones

Mount Hood National Forest

**By Christopher Topik, Associate Area Ecologist
Nancy M. Halverson, Area Ecologist
Tom High, Soil Scientist**

Table of Contents

Chapter One

Chapter Two

Chapter Three

List of Figures

List of Tables

Chapter 1

Introduction and Background

Introduction

Area Covered

This publication describes the forested plant associations of the ponderosa pine, Douglas-fir, and grand fir series found east of the Cascade Crest on the Mt. Hood National Forest. This classification covers most of the Barlow Ranger District, and the eastern and lower elevation portions of the Hood River and Bear Springs Ranger Districts. The vegetation varies from dry ponderosa pine-Oregon white oak savannas with low stocking, to dense, mixed stands of grand fir, Douglas-fir, Engelmann spruce, western larch, and other conifers. The term, *mixed conifer zone*, is often used for the grand fir, Douglas-fir, and ponderosa pine associations described herein.

Why We Classify Plant Associations

Plant associations are groupings of plant species which re-occur on the landscape within particular environmental tolerances. By knowing the plant association of a site we can infer a number of climatic attributes and anticipate site response to various treatments. Associations can be used as a basis for inventory of the productive potential of vegetation and other resources which depend upon vegetation for their quality or quantity. Associations also provide a framework for communicating management experiences and research results.

Four main uses of associations are:

- Describing key environmental features of sites.
- Providing site specificity for understanding management experience and research results.
- Prescription of appropriate management activities to sites, based on better ability to predict site response to treatment.
- A natural inventory system of land resources.

This booklet provides a description of what has been commonly called the *mixed conifer zone* on the Mt. Hood National Forest. This area is environmentally diverse, leading to great differences in the productive potential of timber, wildlife and forage, and in responses to treatment. Careful attention to vegetation helps us understand environmental gradients and prescribe habitat-specific activities which consider the limitations and opportunities inherent to the site. Where particular environments exist in unusual geographic settings, knowledge of plant associations reduces the chances of making costly management mistakes or forgoing opportunities.

Plant Association Classification Terminology

The term **plant association** refers to a stable grouping of plant species capable of self-perpetuation. Plant associations are climax plant communities. They are named after the diagnostic or dominant species in the tree, shrub and herb layers. The name of an association does not necessarily describe its vegetation, but merely designates important species. These species help characterize that plant community which would occur at a stable vegetative condition capable of sustaining itself rather than being replaced by other species. When we refer to the land on which an association occurs we are referring to a **habitat type** (Daubenmire 1968). The collection of plant associations having the same species in the dominant layer is a **series**. Thus, the grand fir series includes all of the grand fir plant associations. We use the term **forest zone** for the land-base on which a particular series is found.

The Term "Mixed Conifer"

The term *mixed conifer* is avoided in this publication because it has such different meanings to various people. To many the term designates any stand having ponderosa pine, Douglas-fir, or grand fir associated with such species as western larch, lodgepole pine and Engelmann spruce. Some think of the *mixed conifer zone* as any place where several conifers, including grand fir or white fir, co-exist. This includes mid to high elevation eastern Cascade forests having the species mentioned above and/or noble fir, subalpine fir, Pacific silver fir, and mountain hemlock. Regionally, the term has been used to describe the portion of Southern Oregon where many conifer species co-exist in small geographic areas. The common link in usage is the co-occurrence of three to eight conifer species in an area.

An understanding of the environmental tolerances of various conifers and of successional pathways allows us to sub-divide the *mixed conifer zone* into forest zones defined by the occurrence of one or two regenerating species. These forest zones generally reflect the extreme moisture gradient of the area, extending from dry, open ponderosa pine forests in sites having only 30 inches of precipitation a year, to dense, high elevation grand fir stands having over 90 inches of precipitation. The term, *mixed conifer*, appropriately describes all of the associations described in this paper, but we should recognize that it is a general concept and subject to misinterpretation.

Definition of Forest Zones

Forest zones are defined by the dominant species in stable, mature stands approximating climax conditions. Most of the stands in the sample area are younger than 150 years and have been strongly influenced by fire prevention activities. We can infer stable state forest composition of a site from the seedling and sapling populations. Thus, in Douglas-fir stands, the presence of grand fir regeneration indicates that the stand is part of the grand fir zone. If Douglas-fir were the only regenerating species, the stand would belong in the Douglas-fir zone. The ponderosa pine zone lacks appreciable regeneration of either Douglas-fir or grand fir.

Ecoclass Codes

Ecoclass codes are 6-digit alphanumeric codes that designate individual plant associations (Hall 1984). The first two digits designate a life-form and series. We use "C" as the first digit to designate coniferous forest. The second digit for the study area is either "P" (ponderosa pine series), "D" (Douglas-fir series), "W" (white or grand fir series), "C" (western redcedar series), or "H" (western hemlock series). Ecoclass codes for the associations described in this paper are listed in Table 1.

Overview of Forest Series

We have hypothesized the relative placement of the forest series and associations along temperature and effective moisture gradients (see Figure 1). The size of the polygons within the ponderosa pine, Douglas-fir, and grand fir series are roughly representative of the commonness of the association on the landscape.

Effective soil moisture is far and away the dominant factor affecting the distribution and abundance of these plant associations. The effective moisture gradient is largely affected by elevation because more precipitation falls at higher elevations. Precipitation drops off rapidly east of the Cascades summit, as well as downwind of major ridges and Mount Hood. Rocky soils and ridgetop sites also have lower effective moisture. The temperature gradient is also affected most by elevation, but anomalies do occur (for example, flatter sites at moderate elevations where cold air accumulates). Plant associations are very helpful to diagnose these areas, as they reflect local variations in environmental conditions.

Ponderosa pine series

This series occurs on hot and dry sites where grand fir and Douglas-fir rarely regenerate and grow, if at all, with very poor vigor. Oregon white oak is a common co-dominant in most of this zone. Ponderosa pine-Oregon white oak woodlands include our most sparsely timbered forest-lands. Numerous herb and grass species occur, including many uncommon species. These are hot and dry sites, particularly during the growing season. Precipitation tends to be low. Soil moisture is rapidly depleted because of shallow soils or because of high evaporative demand on south slopes. The two associations described for this series are floristically similar, and occupy the "hot-dry" corner of Figure 1.

Douglas-fir series

This series, occurring at higher elevations in hot, dry environments, has sufficient moisture to support Douglas-fir regeneration, but insufficient moisture for grand fir. This series features many attractive ponderosa pine forests. Oregon oak is common, but it is as an early successional species, gradually being over-topped and eliminated by ponderosa pine and Douglas-fir. This series generally occupies low elevation sites having low precipitation, and separates the ponderosa pine series from the grand fir series on Figure 1.

Five associations are described in the Douglas-fir series. Douglas-fir/western fescue (PSME/FEOC) is generally found on north aspects with low precipitation. Douglas-fir/pinemat manzanita (PSME/ARNE) represents another extreme. This association occurs on ridges and rocky sites at fairly high elevations having high precipitation, but south aspects and rocky soils lead to effectively dry conditions for plant growth. The other associations are far more widespread. Two include substantial elk sedge. Douglas-fir/oceanspray/elk sedge (PSME/HODI/CAGE) is shrub dominated and occurs on rockier sites at slightly higher elevations than Douglas-fir/elk sedge (PSME/CAGE). The Douglas-fir/common snowberry (PSME/SYAL) association occurs on lower slope positions or protected aspects.

Grand fir series

This series includes those areas where grand fir is expected to comprise at least ten percent of the canopy in stable state (200 years) or climax stands. Forests in this zone often include several other conifers (notably Douglas-fir and ponderosa pine), but grand fir dominates the regeneration. The upper elevation limit of the grand fir zone occurs where abundant moisture and cool temperatures allow development of stands dominated by Pacific silver fir, subalpine fir, or mountain hemlock.

The Grand fir series occupies a large portion of the Barlow Ranger District and is also common in the eastern, lower elevation portions of the Hood River and the Bear Springs Ranger Districts. We have described ten grand

Table 1. List of plant associations of the ponderosa pine, Douglas-fir, grand fir, western hemlock, and western redcedar series on the eastern Cascade portion of the Mt. Hood National Forest.

Alpha code	Common Name	Scientific Name	ECOCLASS CODE	Code in Figures 3-13	page in book
		PONDEROSA PINE SERIES			
PIPO-QUGA/BASA	Ponderosa Pine-Oregon White Oak/ Arrowleaf Balsamroot	Pinus ponderosa-Quercus garryana/ Balsamorhiza sagittata	CPH2 11	BASA	43
PIPO-QUGA/PUTR	Ponderosa Pine-Oregon White Oak/ Bitterbrush	Pinus ponderosa-Quercus garryana/ Purshia tridentata	CPH2 12	PUTR	47
		DOUGLAS-FIR SERIES			
PSME/CAGE	Douglas-fir/Elk sedge	Pseudotsuga menziesii/Carex geyeri	CDG1 41	CAGE	51
PSME/FEOC	Douglas-fir/Western Fescue	Pseudotsuga menziesii/Festuca occidentalis	CDG3 21	FEOC	55
PSME/HODI/CAGE	Douglas-fir/Oceanspray/ Elk Sedge	Pseudotsuga menziesii/Holodiscus discolor/ Carex geyeri	CDS2 31	HODI	59
PSME/ARNE	Douglas-fir/Pinemat Manzanita	Pseudotsuga menziesii/Arctostaphylos nevadensis	CDS6 62	ARNE	63
PSME/SYAL	Douglas-fir/Common Snowberry	Pseudotsuga menziesii/Symphoricarpos albus	CDS6 61	SYAL	67
		GRAND FIR SERIES			
ABGR/CAGE	Grand Fir/Elk Sedge	Abies grandis/Carex geyeri	CWG1 21	CAGE	71
ABGR/HODI	Grand Fir/Oceanspray	Abies grandis/Holodiscus discolor	CWS5 31	HODI	75
ABGR/SYMPH	Grand Fir/Snowberry	Abies grandis/Symphoricarpos albus-Symphoricarpos mollis	CWS3 31	SYMPH	79
ABGR/TRLA2	Grand Fir/Starflower	Abies grandis/Trientalis latifolia	CWF5 21	TRLA2	83
ABGR/LIBO2	Grand Fir/Twinflower	Abies grandis/Linnaea borealis	CWF3 21	LIBO2	87
ABGR/ACCI/ACTR	Grand Fir/Vine Maple/ Vanillaleaf	Abies grandis/Acer circinatum/ Achlys triphylla	CWS5 32	ACCI	91
ABGR/ACTR	Grand Fir/Vanillaleaf	Abies grandis/Achlys triphylla	CWF5 22	ACTR	95
ABGR/CACH	Grand Fir/Chinkapin	Abies grandis/Castanopsis chrysophylla	CWS5 33	CACH	99
ABGR/POPU	Grand Fir/Skunk-leaved Polemonium	Abies grandis/Polemonium pulcherrium	CWF5 23	POPU	103
ABGR-PIEN/SMST	Grand fir-Engelmann Spruce/ Starry Solomonplume	Abies grandis-Picea engelmannii/ Smilacina stellata	CWC5 11	PIEN	107
		WESTERN HEMLOCK SERIES			
TSHE-ABGR/CLUN	Western Hemlock-Grand Fir/ Queencup Beadlily	Tsuga heterophylla-Abies grandis/ Clintonia uniflora	CHC3 11	CLUN	111
		WESTERN REDCEDAR SERIES			
THPL-ABGR/ACTR	Western Redcedar-Grand Fir/ Vanillaleaf	Thuja plicata-Abies grandis/Achlys triphylla	CCF2 11	THPL	115

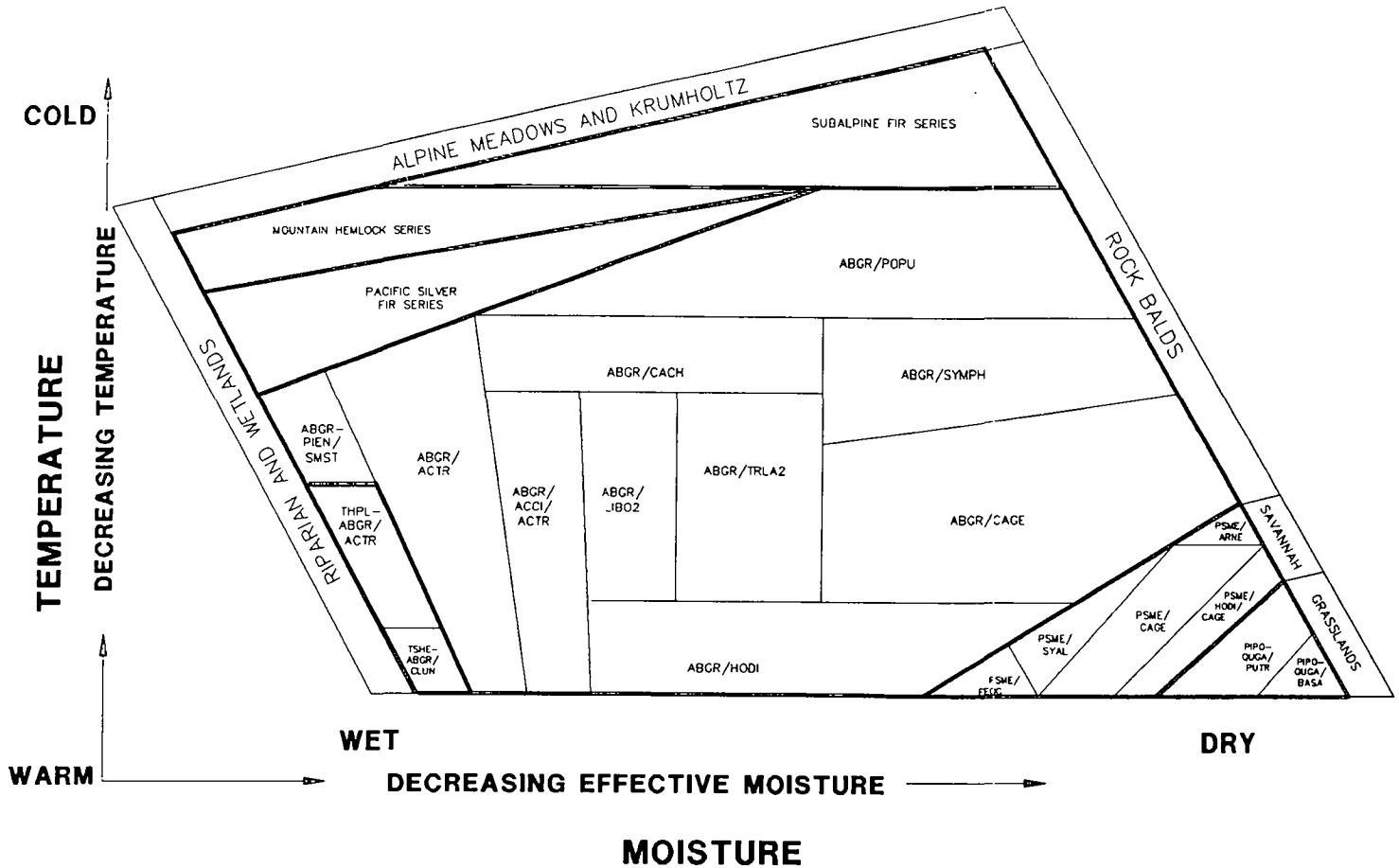


Figure 1. Idealized distribution of associations within a temperature-moisture grid. See Table 1 for a key to the association codes. These axes integrate elevation and aspect-related climatic phenomena. The moisture axis represents precipitation, as well as the moisture-holding and supplying capacity of the soil. Within the Grand Fir, Douglas-fir and Ponderosa pine series, the association polygons are roughly proportional to the association abundance on the landscape.

fir associations. This series includes most of what is commonly referred to as the *mixed conifer zone*. The canopy usually contains Douglas-fir, western larch, and ponderosa pine; grand fir commonly grows up from beneath these early seral tree species. Several other conifers also occur in smaller amounts.

At the extreme hot and dry end of this series, the Grand fir/elk sedge (ABGR/CAGE) association is found. High elevation, moist sites, are represented by the Grand fir-Engelmann spruce/starry solomonplume (ABGR-PIEN/SMST) association. This association includes great plant species diversity, including many conifer and herb species. Similarly cold, but less lush and productive, is the Grand fir/skunk-leaved polemonium (ABGR/POPU) association. Warmer, herb-rich communities with abundant vanillaleaf are common in the more productive moist sites (Grand fir/vanillaleaf (ABGR/ACTR) and Grand fir/vine maple/vanillaleaf (ABGR/ACCI/ACTR) associations). The dry end of the spectrum within this series includes shrub-rich associations: Grand fir/oceanspray (ABGR/HODI), Grand fir/snowberry (ABGR/SYMPH), and Grand fir/chinkapin (ABGR/CACH). The environmental middleground includes Grand fir/starflower (ABGR/TRLA2) and Grand fir/twinflower (ABGR/LIBO2) associations.

Western hemlock and western redcedar series

On Barlow and Bear Springs Ranger Districts stands of western hemlock and western redcedar may be found in low elevation canyon bottoms with abundant soil moisture. These sites also have grand fir and Douglas-fir, but the abundance of western hemlock and western redcedar indicate substantially different local environmental conditions. On the Hood River Ranger District, a more widespread western hemlock zone is found in the western portion at low elevations.

The Western hemlock-grand fir/queencup beadlily (TSHE-ABGR/CLUN) association occurs near major creeks and the low elevation portion of the Bear Springs Ranger District adjacent to the Warm Springs Indian Reservation. The Western redcedar-grand fir/vanillaleaf (THPL-ABGR/ACTR) association also occupies low elevation, moist sites east of the Cascades crest.

High elevation series not included in this report

The Pacific silver fir, mountain hemlock, and subalpine fir series occupy moist, cool to cold sites at high elevations (4000 feet) near the Cascades crest. We have previously described associations from the western Cascades in the silver fir and mountain hemlock series (Hemstrom and others 1982). Our highest elevation forests are included in the subalpine fir series. These sites are colder and slightly drier than mountain hemlock series sites. This series is found at very high elevations on Mt. Hood, at high elevations further east where cold and dry conditions prevail, and in frost pockets where heavy, cold air pools. The highest elevation ridges on Barlow Ranger District include subalpine fir zone sites. A classification of high elevation forest associations is in preparation. These zones are not discussed in this paper.

Methods

This classification is based on data from 196 sample plots located in relatively undisturbed, mature timber stands throughout the eastern portion of the Mt. Hood National Forest. Samples include both reconnaissance plots used primarily to understand vegetation and intensive plots with more detailed measurements of timber stocking and growth, snags, coarse woody debris, and fine fuels. Detailed soil profiles were described on a subset of both plot types.

Reconnaissance Plots

These plots were selected subjectively without preconceived bias (Muller-Dombois and Ellenberg 1974). We used aerial photos and our knowledge of the study area to select sites having as little disturbance as possible and yet representative of the area's floristic variation. On these 500 m^2 circular plots we made complete lists of the vascular flora and ocular estimates of their percent foliar cover (see Appendix 2.) We also noted a variety of physical attributes of the site such as elevation, slope, aspect, landform, etc. We sampled one or two site trees representative of the best growth in the plot vicinity and we did a variable radius basal area measurement at plot center using either a 20 or 40 BAF prism. We also photographed each plot.

Intensive Plots

Each of these plots included a reconnaissance plot as well as these additional measurements:

Live Tree Stocking and Growth

We sampled 3-5 site trees of each major species present on the plot. These site tree data include height, crown ratio, diameter at breast height (DBH), age at breast height, bark thickness, sapwood thickness, recent decade's radial growth, and basal area of the surrounding stand (for growth basal area calculation, Hall 1988). The major species site index curves used are Curtis (1974) for Douglas-fir, Barrett (1978) for ponderosa

pine, and Cochran (1979) for grand fir. The latter is a 50 year base curve whereas the former two curves are indexed to age 100. Other site index curves used were Cochran (1985) for western larch, Dahms (1975) for lodgepole pine, Brickell (1970) for Engelmann spruce and western white pine, and Barnes (1962) for western hemlock. Each intensive plot included 5 variable radius basal area plots: one at plot center and one at each cardinal direction 100 feet away (slope corrected distance). In those situations where abrupt ecotones existed, we adjusted the placement of the outlying plots to be on parallel lines within the relatively homogeneous sample area. We measureed the diameter of each "in" tree in the variable radius plots so we can calculate number of trees per acre by size class and species, as well as Reineke's (1933) stand density index (SDI).

Snags

Standing snags (minimum size 10 in. DBH and 10 feet tall) in three variable radius plots (center, north and south) were measured for DBH, height class, decay condition class, cavity number class, and species. The height classes are 10-30 feet, 31-50 feet and greater than 50 feet. The cavities counted are potential nesting openings which clearly appear to be animal created. The cavity classes are: 0; 1-3; 4-7; and greater than 7. The snag condition classes used are becoming standard in the region (Maser and Trappe 1984):

Condition 1: Fine branches and bark intact

Condition 2: A few larger limbs present, bark present

Condition 3: Limb stubs may be present, bark only partly intact

Condition 4: Bark nearly gone; solid buckskin

Condition 5: Rotted, soft and crumbly

Fallen Trees and Fine Fuels

We utilized the plane transect method of Brown (1974) to quantify down woody debris and fine fuels (less than 3 inch diameter). We used two parallel 100 foot long transects for coarse woody debris on each intensive plot and four short transects for the fine fuels: 10 feet long for 1-3 inch diameter pieces, 6 feet long for 1/4-1 inch diameter pieces, and 3 feet long for 1/4 inch diameter pieces. The fine fuels are categorized as 1-hour (1/4 inch diameter), 10-hour (1/4 to 1 inch diam.), and 100-hour (1-3 inch diam.) fuels (Deeming et al. 1978). Our calculations of fine fuel weights used Brown's composite values for squared average-quadratic mean diameters and his "others" values for the average secant of non-horizontal particle angle for correcting orientation bias. Coarse woody debris (greater than 3 inch diameter) were tallied according to size and deterioration condition classes. Diameter and length were also recorded, thus allowing us to calculate total volume and weight. The size classes are:

Size 1: Piece does not contain a segment which is at least 6 in. in diameter for a length of at least 5 feet.

Size 6: Piece contains a segment which is 6 inches in diameter or larger for a length of at least 5 feet.

Size 12: Piece contains a segment which is 12 inches in diameter or larger for a length of at least 5 feet.

Size 20: Piece contains a segment which is 20 inches in diameter or larger for a length of at least 5 feet.

Condition classes indicate relative states of decomposition. We modified the classification of Maser and Trappe (1984):

Condition 1: intact bark and wood, fine branches present (Maser and Trappe (1984) condition class 1)

Condition 2: bark loose, fine branches absent, wood intact or partly soft. slightly sagging (Maser and Trappe (1984) condition class 2)

Condition 3: bark usually absent, no fine branches, wood soft to powdery, may be somewhat oval in cross-section, all of piece is on the ground (Maser and Trappe (1984) condition classes 3 and 4)

We did not tally highly decomposed pieces (Maser and Trappe (1984) condition class 5).

Soils

Soil profiles (105 total) were described on most intensive plots and on many reconnaissance plots. A soil pit was excavated to a depth of 100 cm or to bedrock if less than 100 cm. The soil profile was described in accordance with standards and methodology contained in the Soil Survey Manual (Soil Survey Staff 1975) and the National Soils Handbook (USDA, Soil Conservation Service). The soil pit was located as close to plot center as possible, except when that location was deemed not representative.

Determining the Classification

Individual plant associations were designated on the basis of four classification criteria (Hall 1984):

- Do they have a distinctive flora?
- Do they have different productive potentials?
- Are there distinctive management implications?
- Are they identifiable on the ground?

We used a combination of subjective and objective classification methods. Computer-based methods involved

construction of initial plot ordering tables (Volland and Connelly 1978) which were compared with results from detrended correspondance analysis (DECORANA) (Gauch 1977 plus supplements; Gauch 1982). Two-step indicator species analysis (TWINSPAN) was used to examine the classification value of various species and plot groups. These results were used to re-order the subjective association groupings. Old-growth plots were more heavily weighted as they reflect the eventual floristic composition which define associations.

Similar ecological data from the grand fir zone on the Gifford Pinchot National Forest were combined with these data to evaluate the possibility of using one classification for these zones on both National Forests. Several associations on both National Forests are somewhat similar floristically, but substantial differences in productive potential and therefore, management implications, argues against lumping these data to describe single associations.

The preliminary association classification and keys were field-tested for a season to examine their identifiability and integrity. Comments from these tests and outside review were considered.

Climate

The climate on the east slope of the Cascades combines features of maritime and continental regimes (Franklin and Dyrness 1973). Dominant characteristics are the rain shadow effects of the Cascade crest, elevation-related temperature differences, and very low summer precipitation.

The rapid decline in precipitation with distance east of the Cascade crest is clearly illustrated in the isohyetal map (Figure 2), showing a drop from 90 to 20 inches per year. The actual local patterns are probably much more complex. We postulate that the northern portion of the Barlow Ranger District is generally drier than further south because winter storms from the southwest are impeded by Mt. Hood. The Forest-wide precipitation map also may underestimate the importance of the major escarpment on the eastern edge of the Hood River Valley leading from Surveyor's Ridge to Gumjuwac Saddle. East of escarpment the climate becomes drier due to increasing distance from the Cascade crest, the blocking effect of the escarpment, and because of decreasing elevations.

In general, increasing elevation is associated with lower temperatures, more precipitation as snowfall, and higher precipitation levels, because cooler air masses have lower moisture holding capacity. This generalization, in our area, is complicated by the rain shadow effect of Mt. Hood and the Cascade Crest. Thus, low elevations (below 3000 feet) on the Barlow Ranger District are quite dry (largely because these sites are so far east of the Cascade crest), while the same elevations on the Hood River and Bear Springs Ranger Districts are considerably more moist.

The east slope of the Cascades receives only scant summer rainfall from maritime storms. Thundershowers appear to be more prevalent at higher elevations. The eastern edge of the Mt. Hood National Forest has a much longer period of summer drought than elsewhere on the Forest. This feature is of primary importance to vegetation composition and productivity.

The effective moisture concept integrates the factors which affect water availability for plant growth and evapotranspiration. Though incident moisture varies from 20 to 90 inches per year, effective moisture is much more variable. It is strongly affected by local soil and topographic characteristics, such as bedrock fracture, slope, soil depth, stoniness, texture, structure, organic matter content, and aspect. When we discuss moist- or dry-site plant associations, we are referring to the effective moisture of the site. Plant associations in this area are strongly influenced by moisture, and thus are good indicators of differences in moisture between sites.

Figure 3 illustrates variation in annual precipitation within and among plant associations. These values are based on plot values estimated from the Mt. Hood National Forest hydrologist's isohyetal map depicted in Figure 2. The ponderosa pine series associations average less than 30 inches per year, whereas the high elevation grand fir series types, (Grand fir/Skunk-leaved polemonium (POPU), and Grand fir-Engelmann spruce/Starry solomonseal (PIEN)) range up to 90 inches per year. The height of the individual bars in Figure 3 depicts the estimated variability of precipitation within an association. For instance, the great variation within the Douglas-fir/Oceanspray/Elk sedge (HODI) association indicates that it is found both at sites having very low incident rainfall, and high precipitation sites with very low effective moisture due to soil conditions.

Elevation affects climate greatly and is especially important as the controlling factor of temperature and precipitation. A good deal of the precipitation variation of associations is due to elevation effects.

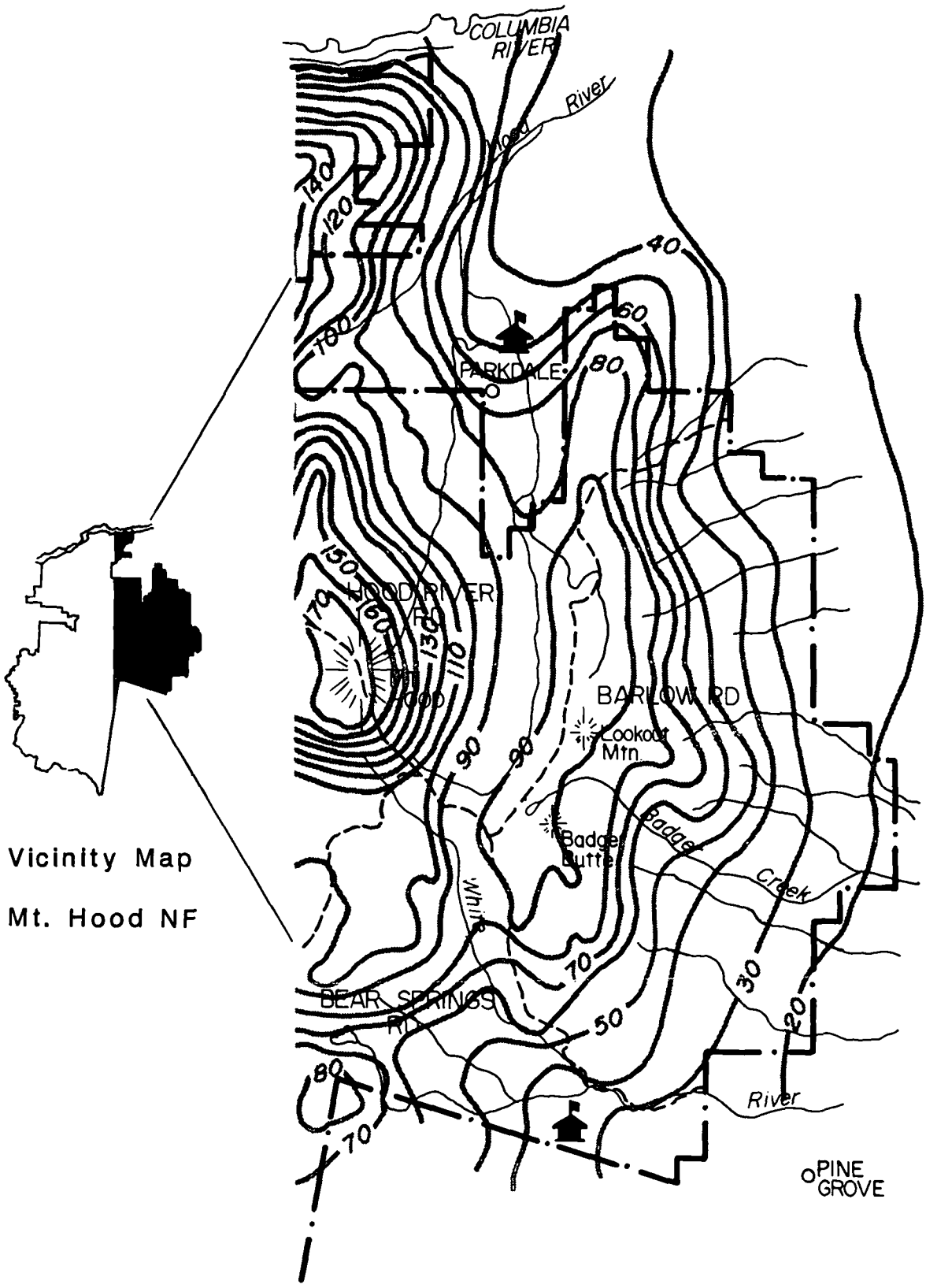


Figure 2. Average annual precipitation (inches per year) for the eastern portion of the Mt. Hood National Forest. Constructed by Mt. Hood NF hydrologist, based on U.S. Weather Bureau maps and field stations.

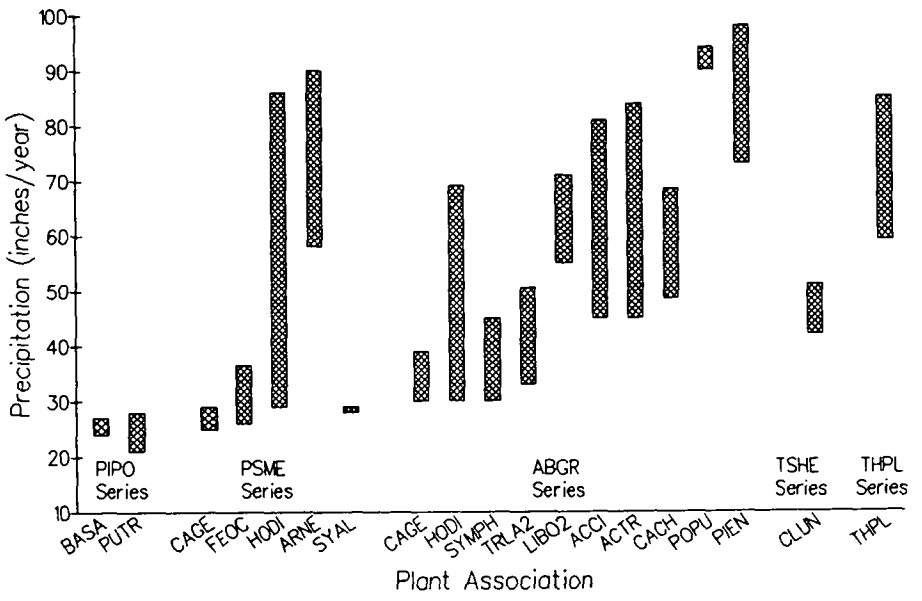


Figure 3. Range in average annual precipitation for sample plots in each plant association. See Table 1 for a key to each association code. The values for each plot come from the Mt. Hood NF precipitation map (Figure 1).

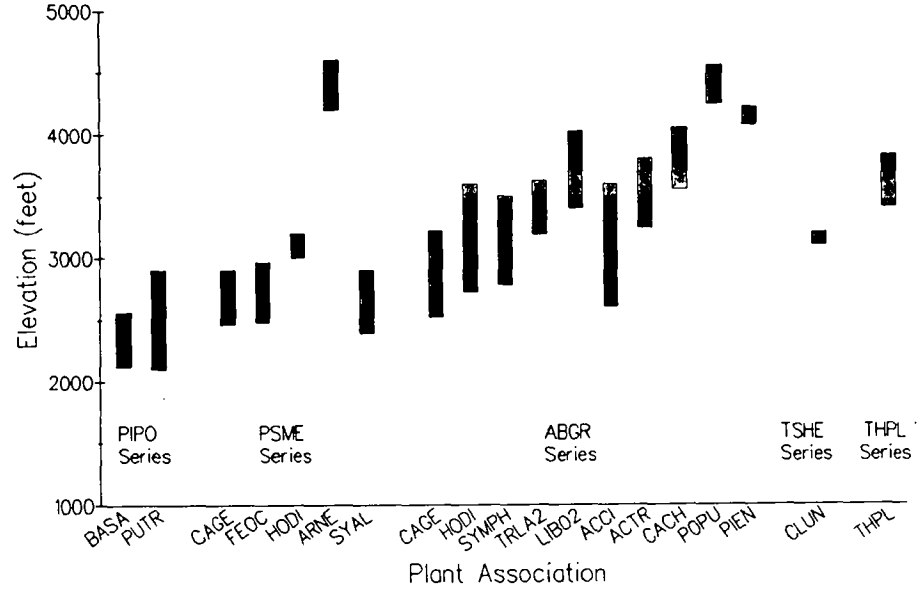


Figure 4. Range (midle 75%) in elevation for sample plots in each plant association. See Table 1 for a key to each association code. Each bar indicates the middle 75% of the range of sample plot elevations in that association.

Figure 4 shows the elevation ranges of plant associations in this area. There is a clear trend of increasing elevation from the more dry plant associations to the more moist. The distinctively anomalous association, Douglas-fir/pinemat manzanita (ARNE), may occur at high elevations but is associated with rocky ridgetops having low effective moisture. This association represents an edaphic climax community (*sensu* Tansley 1935).

Aspect also greatly affects local climates. The aspect break-down of plots in each association is presented in Figure 5. In general, moisture is most abundant on north and east slopes because evaporational demand is less than on south or west slopes. This generalization is complicated by the differences in incident precipitation, however. For example, the Douglas-fir/Western fescue (FEOC) association has low rainfall (28-38 in/yr) but occurs on north slopes. The protection from direct sun (and lower evaporational demands) leads to better plant growth than average for sites with low rainfall. Western aspects are uncommon throughout the entire study area because so much of the landscape is dominated by the eastward declining ridges of the Barlow Ranger District.

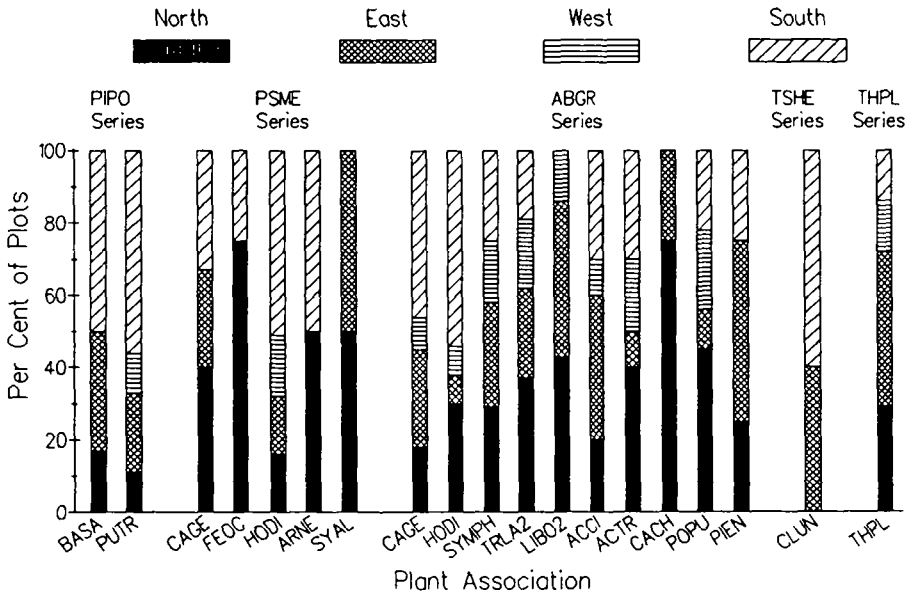


Figure 5. Percent of plots within each association having north, east, west or south aspects. See Table 1 for key to each association code.

Soils

Importance of Geology to Soils

The soils on the east side of the Mt. Hood National Forest have formed mainly from parent materials of volcanic origin (Bela 1982). The oldest rocks exposed in this area are derived from mudflow material which probably originated from an ancient volcano in the area of present day Mt. Hood. This formation is known as the Chenowith member of The Dalles group and consists of andesite and basalt gravel, cobbles and boulders embedded in an ashy matrix. This formation is about 10 million years old and overlies Columbia River Basalt. It spread eastward in a series of flows prior to the downfaulting of the East Fork of Hood River Valley, forming a broad dissected terrace.

The soils that formed from these sediments are typically shallow, moderately coarse-textured and contain many rock fragments within the soil and on the surface. The ashy matrix of these sediments is cemented in most places making it impervious to water and largely unpenetrated by roots.

Approximately 5 to 8 million years ago, lava flows spread eastward covering the old sediments to near the eastern boundary of the Mt. Hood National Forest. This lava is extensive throughout the western Cascades. The leading edge of these flows commonly ends in steep scarp walls. This lava is interbedded with tuff and tuff breccia resulting from accompanying pyroclastic flows and consolidated tephra deposits. The lava is hard, fractured, porphorytic basalt. The soils that formed from this material are shallow to moderately deep, medium-textured, and contain many rock fragments in the soil and on the surface. The tuff and tuff breccia derived soils are fine-textured and relatively rock-free.

Mill Creek Buttes are volcanos of approximately the same age and composition as Mt. Hood. These volcanos produced andesite and basalt flows about 500,000 years ago. Soils developed in these materials are shallow to moderately shallow, medium-textured, and contain many angular rock fragments.

The youngest geological material in this area is a mantle of volcanic ash and loess. The volcanic ash likely originated from Mt. Hood but minor amounts of ash from Mt. St. Helens are likely included. The loess is wind-blown silt that originated on the Columbia River floodplains after glacial floodwaters receded. The texture of this material is very fine sand to fine sand. It is as deep as 40 or more inches in the western, high elevation areas, thinning to a few inches near the eastern boundary of the Mt. Hood National Forest. This material has undergone very little alteration since deposition. Structure is weak and little organic matter has accumulated. This volcanic ash forms the surface layer of almost all of the soils in this area. It holds considerable amounts of water, a fact of primary importance to plant distribution and productivity.

Importance of Climate to Soils

The elements of climate, acting upon the above-mentioned parent materials, have probably played the greatest role in differentiating soil types. For the most part, as elevation increases, precipitation increases and

temperature decreases. East of the Hood River Valley this relationship forms a rather distinct east to west gradient.

Soil temperature has an important influence on the biological, chemical and physical processes in the soil. Soil temperature regimes relate closely to growing season length. Three classes of soil temperature are recognized in this area. Mesic soils are the warmest, and range up to about 2500 feet in elevation. Frigid soils have a cooler mean annual temperature but are warm during the growing season. This regime ranges up to about 4000 to 5000 feet. Cryic soils are higher in elevation and are characterized by cool temperatures during the growing season.

The soil moisture regime is an index of the supply of moisture during the growing season. The Xeric soil moisture regime is characterized by soils that are dry during most of this period. These soils range up to about 5000 feet in elevation. Above this are soils with a Udic moisture regime. These soils usually contain some available moisture throughout most of the growing season.

Soil Fertility

Soil fertility depends largely on the soil's ability to supply roots with moisture, chemical nutrients, and oxygen. Soil organic matter supplies critical nutrients, as well as cation exchange and moisture holding capacity. Precipitation and temperature control the rate at which organic matter is produced and incorporated into the soil. As organic matter incorporation into the soil proceeds, nutrients are released and made available to plants. Water moving through the soil removes basic minerals from upper horizons and increases acidity. Figure 6 illustrates the base saturation of several representative soils plotted against depth. The level of base saturation is a rough measure of the soil's chemical fertility. Generally, the higher elevation or more moist-site soils have fewer nutrients due to leaching losses. Thus, on a chemical basis, the Grand fir/snowberry (ABGR/SYMPH) and Grand fir/vanillaleaf (ABGR/ACTR) soil samples have greater fertility than the other two samples from moister sites. The great difference in annual precipitation among these samples is a better predictor of site fertility than are the chemical properties.

The soil moisture retention curves for the surface layer of several representative soils is presented in Figure 7. Total porosity averages about 50 to 60 percent. The soil is saturated when these pores are filled with water. Unfortunately, about half of this water is lost through sub-

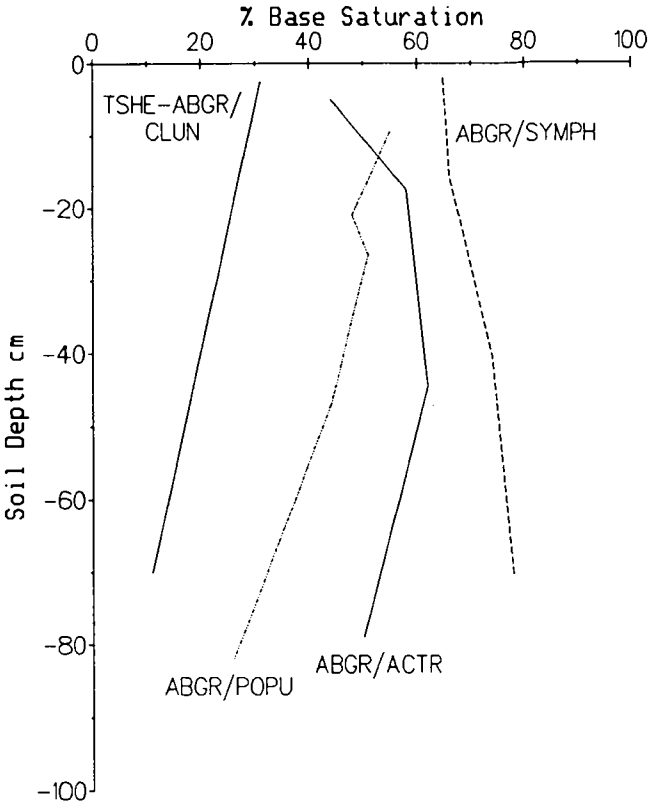


Figure 6. Soil base saturation for four soils from The Dalles watershed representative of four associations. See Table 1 for key to association codes. Analysis performed by soils laboratory, Oregon State University.

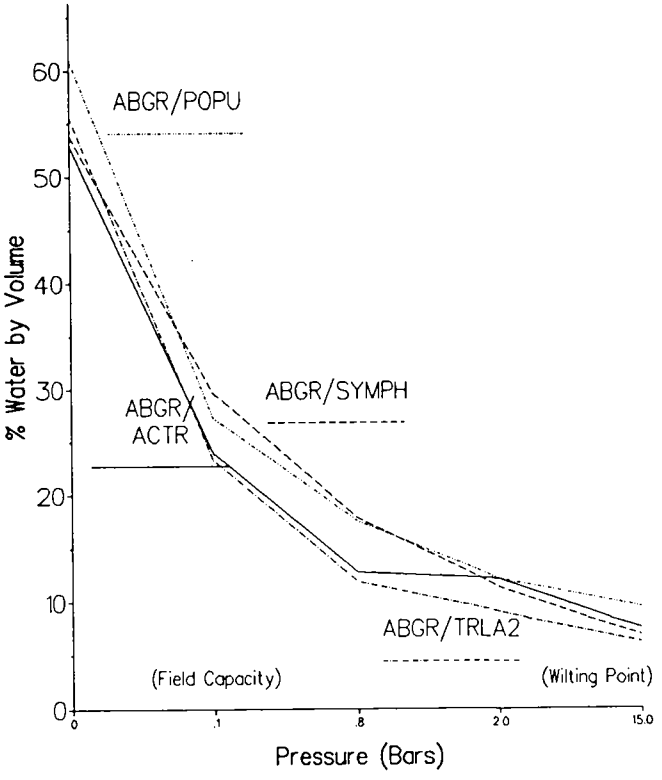


Figure 7. Soil moisture release curves for four soils from The Dalles watershed representative of four Grand fir series associations. See Table 1 for key to association codes. Analysis performed by soils laboratory, Oregon State University. The water content at wilting point indicates that, at most, 10% of soil water is unavailable to plants.

surface flow. Moisture held at field capacity averages about 25 to 30 percent by volume. At wilting point the moisture remaining is only about 5 to 10 percent, which means that most of the water retained by these soils is available to plants. The four samples illustrate that, in general, the soils of the grand fir series have quite similar physical properties.

Soil texture, organic matter content, and rock fragment content strongly influence the total amount of water that the soil can store. An index of soil rockiness and depth is called **effective soil depth**. Values are presented for each association in the type descriptions. Effective soil depth is calculated by multiplying the soil profile depth by the proportion of the soil consisting of sand or finer size particles. Thus, this index excludes that proportion of the soil occupied by coarse fragments (which do not supply effective rooting) from the total soil depth. Generally, the higher elevation soils have the thickest volcanic ash mantle and the fewest rock fragments in the root zone, and, therefore, the highest available water capacities.

Nitrogen generally is the most limiting nutrient to plant growth in western forest soils. Total soil nitrogen levels are exceptionally low on many of the soils on the eastside of the Mt. Hood National Forest (figure 8). We have included two westside samples, Western hemlock/swordfern-oxalis (TSHE/POMU-OXOR) and Pacific silver fir/oxalis (ABAM/OXOR), to illustrate how low these eastside values are. Nitrogen content is highest in the surface layers and generally decreases with increasing depth. Slight increases in deeper layers are due to the presence of older, buried surface layers. The low level of nitrogen in these soils indicates a likely response to fertilization. Total nitrogen seems to be slightly higher in soils of the higher elevation, cooler and moister plant associations. The suspected cause is the higher frequency of fire that occurred in the lower elevation areas before the advent of fire suppression. Repeated burning may have caused considerable amounts of nitrogen to be volatilized.

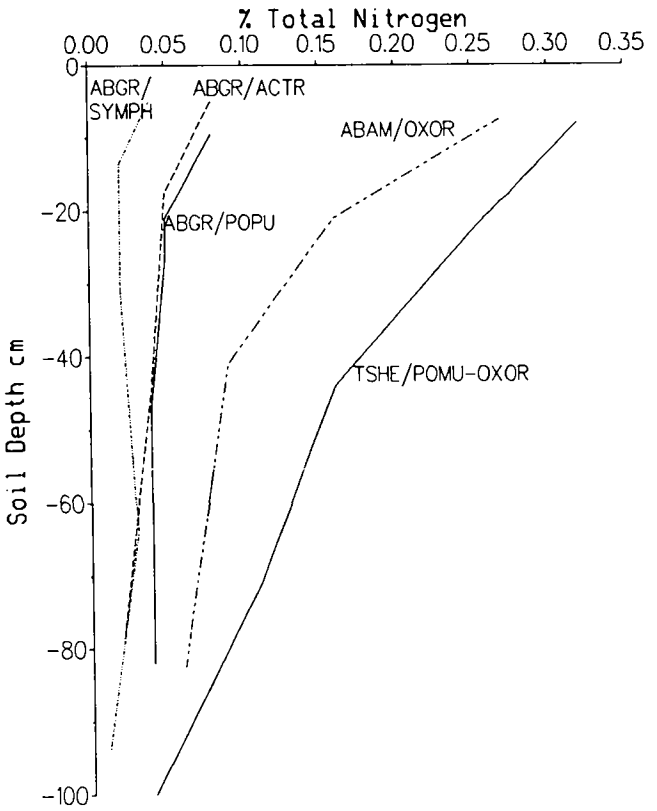


Figure 8. Soil nitrogen content for three soils representative of three Grand fir series associations within The Dalles watershed. See Table 1 for key to association codes. Mt. Hood NF (western Cascades) Pacific silver fir zone (ABAM/OXOR) and Western hemlock zone soils (TSHE/POMU-OXOR) are included for reference.

Soil Management Considerations

Of the environmental factors necessary for plant growth, soil moisture, temperature and nutrients are the most likely to be impacted by management activities. Soil organic matter, including the forest floor (duff layers), plays a key role in determining soil fertility, and it is also easily impacted by some treatments.

In undisturbed conditions forest soils have a great capacity to absorb moisture and the overland flow of water rarely occurs. The forest floor (litter or duff layer) absorbs water readily and transmits it to the mineral soil below. This is especially important since the exposed surface of the volcanic ash topsoil is inherently water-repellent. Without a litter layer, raindrops striking the ground can detach soil particles and seal the surface pores of the soil. This can cause overland flow, reducing the amount of water available to plants, and resulting in erosion and loss of fertility. The litter layer also helps to conserve soil moisture by reducing evaporation from the soil surface.

Soil temperatures in the root zone of tree seedlings can reach lethal levels on south-facing slopes with no shade or litter cover. On these sites leaving shelter trees for shade may be necessary to maintain cooler soil temperatures. Maintaining some litter cover insulates the mineral soil from high daytime temperatures and helps keep the soil warm at night.

In addition to moderating soil temperatures and helping to conserve soil moisture, the forest floor contains most of the nutrients which are cycled through the soil. Also, decomposing woody material is important for free-living, nitrogen-fixing bacteria, for the development of mycorrhizal fungi, and as an excellent water-saturated rooting medium.

Site preparation objectives often require removal or displacement of some of the duff layer to aid in the establishment of tree seedlings. Even where exposure of mineral soil is desired for natural seedling establishment, the amount should be limited. Twenty to thirty percent mineral soil exposure is usually adequate if it is evenly distributed throughout the area. Where tree planting is prescribed, removal of the litter and duff should be confined to only that which is necessary to plant the trees.

Plant growth can also be limited by disturbance to the mineral soil through compaction by heavy equipment. This results in a loss of large pore space which, in turn, reduces the available moisture in the soil. Soil compaction also impedes root growth and reduces the gaseous exchanges necessary for healthy roots.

Loss of nutrients through topsoil erosion can reduce plant growth. The surface mineral soil layers are by far the most critical for root uptake of nutrients. The low density of surface layers is due to the volcanic ash material and high organic matter contents. These surface soils can be easily displaced and eroded by overland flow of water, severely impacting the long-term productive potential of the site.

The key to maintaining soil fertility is conserving and enhancing soil organic matter, either in the form of surface litter layers or humus incorporated into the mineral soil matrix. Organic matter has high concentrations of readily available nutrients, high moisture-holding capacity and high nutrient exchange potential. It fosters soil structure development which enhances water, air, and root movement throughout the soil profile. Soil biological activity is dependent upon a sufficient quantity and quality of soil organic matter.

Overview of Soils by Series

Ponderosa pine series

The soils of the Ponderosa pine associations are dry through much of the growing season. These soils have thin litter layers and moderate levels of organic matter in the topsoil because litter accumulates slowly on these sites. In the past, frequent fires also regularly removed considerable amounts of litter. The soil pH is neutral to slightly acid and the concentration of bases is high due to low precipitation and leaching rates.

A unique feature of a small portion of this area is patterned ground, also known as biscuit-scabland. The biscuits are mounds of relatively rock-free soil that support oak and bitterbrush. The scabs, or intermound areas, are quite shallow and contain many rock fragments. With much less capacity to supply water, the intermound areas can support only grasses and forbs.

The soils of the Ponderosa pine associations are classified as fine loamy or loamy-skeletal, mixed, mesic Typic Xerochrepts, Typic Eutrochrepts or Typic Haploxerolls (Soil Survey Staff 1974).

Douglas-fir series

In the Douglas-fir zone the litter layers are thicker and include a layer of partially decomposed material. Moderately warm temperatures and increasing amounts of moisture favor the incorporation of considerable amounts of organic matter into the topsoil. These soils have the thickest organic-rich topsoil layers of any on the eastside of the Mt. Hood National Forest. Soil pH is slightly acid to moderately acid and base saturation is fairly high.

Although these soils are quite fertile, plant growth is limited by low moisture during the growing season. Since the forest floor acts as a mulch (which reduces evaporation of critical soil moisture) and also moderates soil temperatures, (further reducing moisture stress) it should be conserved. Also, the litter layer is the source of most of the nutrients which are re-cycled through the soil, and it protects the the soil from raindrop impact and erosion.

The soils of the Douglas-fir associations are classified as loamy-skeletal, mixed, mesic to frigid, Typic Haploxerolls or Typic Argixerolls.

Grand fir series

Further west and higher in elevation the soils have a significant amount of volcanic ash on the surface. With more available soil moisture, grand fir associations are prevalent. These soils have moderately thick litter layers. The drier grand fir associations (eg. Grand fir/elk sedge, ABGR/CAGE) have fairly thick, organically-enriched topsoil layers, whereas the higher elevation associations (eg. Grand fir/vanillaleaf, ABGR/ACTR), have thicker litter layers and thinner topsoils. The high elevation Grand fir/skunk-leaved polemonium association (ABGR/POPU) generally has a thick forest floor. Soil pH is moderately to strongly acid and base saturation is moderate to low.

Fertility of these soils tends to be lower than at lower elevations or drier sites. However, since the growing season is fairly long and the volcanic ash surface layers supply considerable moisture, these plant associations

are quite productive. Minimizing the amount of disturbance to the volcanic ash topsoil is essential to maintenance of long-term site productivity. This material is weakly structured and will erode readily if unprotected. It is susceptible to compaction by heavy equipment operations over a wide range of moisture contents. Thus, heavy equipment use should be minimized even on dry soils.

The soils of the grand fir associations are classified as loamy or medial over loamy skeletal, mixed, frigid Andic Xerochrepts, Andic Haplumbrepts, Andic Dystrochrepts, or Typic Vitrandepts.

Timber

The plant associations described in this paper include a diverse mixture of 13 conifer species, occurring in a great variety of combinations. An understanding of their different ecological tolerances and successional roles helps us classify this environment into meaningful units, plant associations, which have distinctive implications to timber managers. Although the plant associations are described and named according to their dominant tree species at long term stable conditions (climax), these shade tolerant species are frequently less abundant than early successional species. Indeed, higher timber production or values may be seen in stands composed of early successional species.

Successional Status of Tree Species

During pre-settlement times fire was a critical and constant part of eastern Cascade ecosystems. The advent of fire suppression has allowed shade tolerant, fire sensitive species, such as grand fir, to dominate much of their environmental zone. Without fire supression, the grand fir zone would be dominated by ponderosa pine and Douglas-fir, two species with superior fire resistance when they attain large size. Never-the-less, the zone would still be properly termed "the grand fir zone" because this species is capable of eventually out-competing ponderosa pine and Douglas-fir where sufficient moisture is available. True climax species are those which can persist and reproduce in their own shade in the absence of disturbance.

Individual tree species can serve either pioneer (early successional) or climax (late successional) roles, depending on their adaptation to the environment. Our major pioneer species are not shade tolerant and play climax roles only where dry or harsh conditions prevent dense canopy formation. The pioneers include high value timber species: ponderosa pine, Douglas-fir, western larch, noble fir, and western white pine, as well as Oregon white oak and lodgepole pine. Several of our species are rarely abundant in young, early successional stands. These include shade tolerant species: grand fir, western hemlock, western redcedar, and Pacific silver fir. Subalpine fir and mountain hemlock have intermediate shade tolerance. They can be either pioneers in intermediate environments, where they would eventually be excluded by grand fir or silver fir, or climax species, where cold and harsh conditions prevent the less cold-adapted trees to persist.

Tree Species Distribution

Canopy coverage, by association, of the three main tree species (ponderosa pine, Douglas-fir and grand fir) shows the replacement of ponderosa pine by grand fir in the more moist and higher elevation plant associations (Figure 9a). Douglas-fir is widespread in all of these associations. Grand fir is nearly absent from the dry ponderosa pine and Douglas-fir series. Ponderosa pine dominates the dry associations, but also occurs as an important seral species throughout the heart of the Grand Fir Series.

Western larch and lodgepole pine are also extremely important species on the eastern portion of the Mt. Hood National Forest. Both are early successional species which, in the absence of fire, would usually be replaced by grand fir in this area. Larch is virtually absent from the ponderosa pine and Douglas-fir series. It is an important stand component of the moderately moist to moist portions of the grand fir zone. During the past decade the larch casebearer killed many larch trees on the Mt. Hood National Forest, particularly in the vicinity of White River. Lodgepole pine is most abundant as a pioneer following hot fires. It also dominates various harsh environments, from very frost-prone pockets to sites having perched water tables. Lodgepole pine also dominates sites having ultra-xeric soils (such as recent volcanic mudflows).

The other conifer species have much more restricted eastern Cascades distributions in both time and space (see Appendix one for species abundance by plant association). Western hemlock and western redcedar grow primarily in well shaded, moist sites where summer drought is less severe than in other parts of the study area. Mountain hemlock, Pacific silver fir and noble fir also are abundant in high precipitation areas, but where high elevations are accompanied by heavy snowfall. Subalpine fir co-occurs in many of these cold sites but it dominates where slightly drier conditions prevail. Hence, at a given elevation, subalpine fir increases its relative dominance over mountain hemlock as one

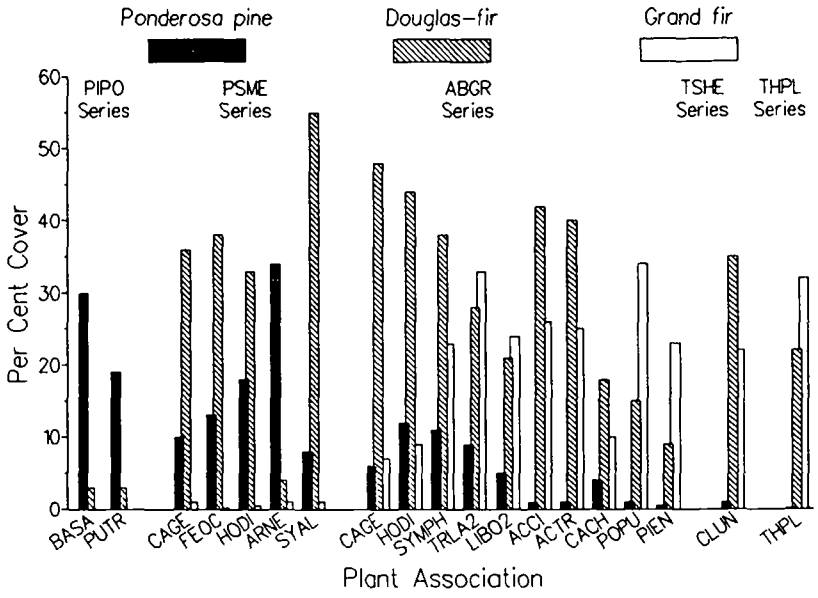


Figure 9a. Average percent overstory canopy cover, by plant association, for ponderosa pine, Douglas-fir and grand fir. See Table 1 for key to association codes. Note: these are not mean relative cover values as presented in Appendix 1 and the association descriptions.

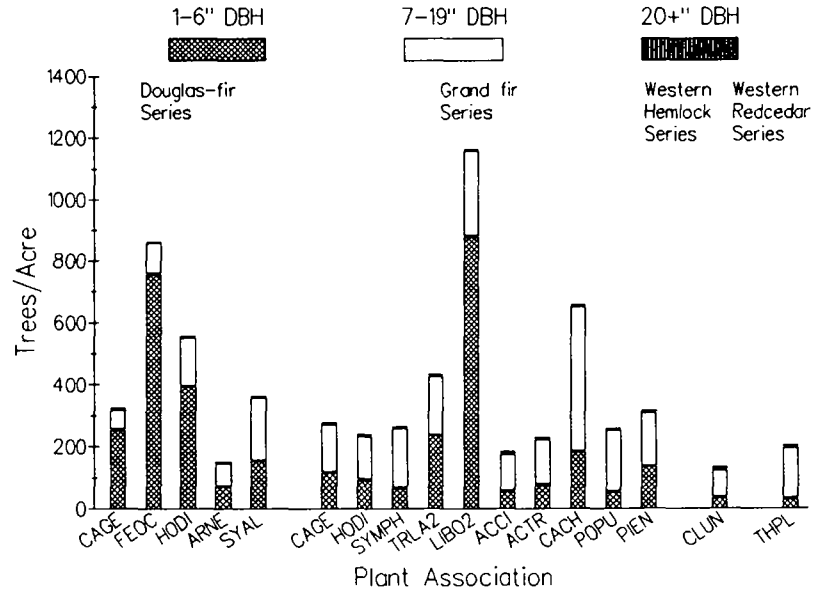


Figure 9b. Average number of trees per acre, by three size classes, for each plant association. See Table 1 for key to association codes.

travels east along a decreasing moisture gradient. Western white pine is never abundant, but occasional individuals are found throughout the more moist portions of the grand fir zone. It was much more widespread and abundant before the spread of white pine blister rust. The occurrence of some Engelmann spruce is common in a wide variety of mesic grand fir zone sites and this species dominates cold, moist sites.

Timber Stocking

Timber stocking (Figure 9b) values for individual plant associations are confounded by the various age classes of our sample plots. In general, the more moist associations have large trees and fairly low stocking levels. Stands having larger diameter trees tend to have fewer trees per acre. The exceptionally high stocking value for the Grand Fir/Twinflower (ABGR/LIBO2) association results from a few sample plots having dense grand fir understories. Density management in such stands would increase commercial timber yields. The pattern of total live basal area displayed across the linear association ordination (Figure 10) also highlights the slightly higher timber values in the more moist associations and the relatively similar composition of much of the Grand Fir zone.

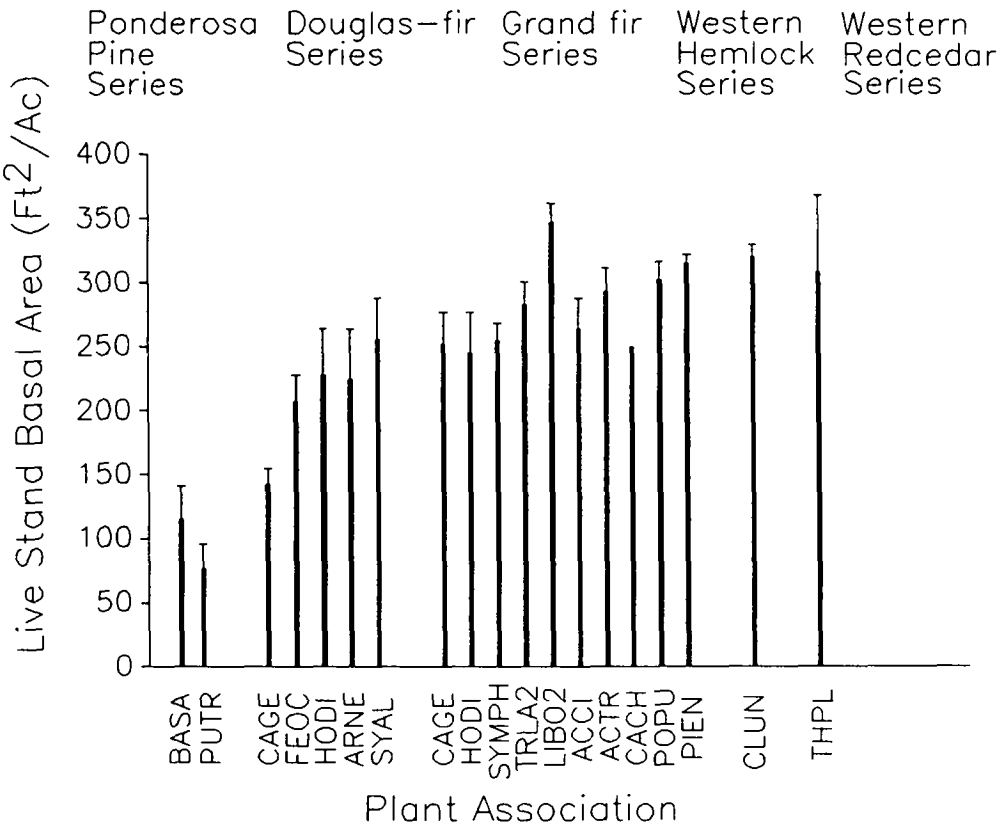


Figure 10. Average live tree basal area (square feet per acre) for each association. The narrow bars indicate the mean plus one standard error of the mean. See Table 1 for key to association codes.

Timber Growth and Productivity

Site indices serve as useful guides to relative site productivity by indexing maximum tree height growth to a common age (either 100 or 50 years). Where both Douglas-fir and ponderosa pine were sampled, Douglas-fir usually had the higher site index (Figure 11a). However, other factors, such as unknown differences in age to breast height or risk of regeneration failure, may be more important evaluation criteria when deciding which species to plant. The site index chart for grand fir shows the absence of grand fir site trees in the Douglas-fir and ponderosa pine series (Figure 11b). Grand fir site index shows very little variation related to plant associations.

Another productivity index, growth basal area (Hall 1988), indexes site stockability. It is defined as that basal area at which trees on average increase one inch radially per decade at age 100. Growth basal area more clearly demonstrates the differences in stand productivity across the moisture gradient separating the associations (Figure 12). In general, ponderosa pine growth basal area increases from ponderosa pine to grand fir associations, but falls off at the more moist end of the gradient. Douglas-fir growth basal area increases fairly steadily with increasing moisture (from left to right on the association ordination). Grand fir growth basal area is highly variable from association to association.

Timber volume productivity can be estimated in many ways. We present one method in Figure 13 which adjusts normal yield tables by site index and stocking (stand density index). This productivity index is useful primarily to compare relative values among associations. The values index potential maximum production (total cubic volume/acre/year) at culmination of mean annual increment. The range in values (38 to 158) demonstrates that timber production is an important resource within the study area. Though there is some overlap, these values are generally lower than those found in our western hemlock zone (Halverson et al. 1986) and Pacific silver fir zone (Hemstrom et al. 1982) plant associations. The wide error bars demonstrate that there is considerable variability within our estimates. Much of this may be due to the varied ages of the sample plots within each association.

We did not do intensive timber measurements on the ponderosa pine series plots because of their very poor timber stocking. Based on the low site index values for the ponderosa pine associations (see Figure 11a), and the low stocking, the productivity index values for these associations would probably be about 30 cubic feet per acre per year.

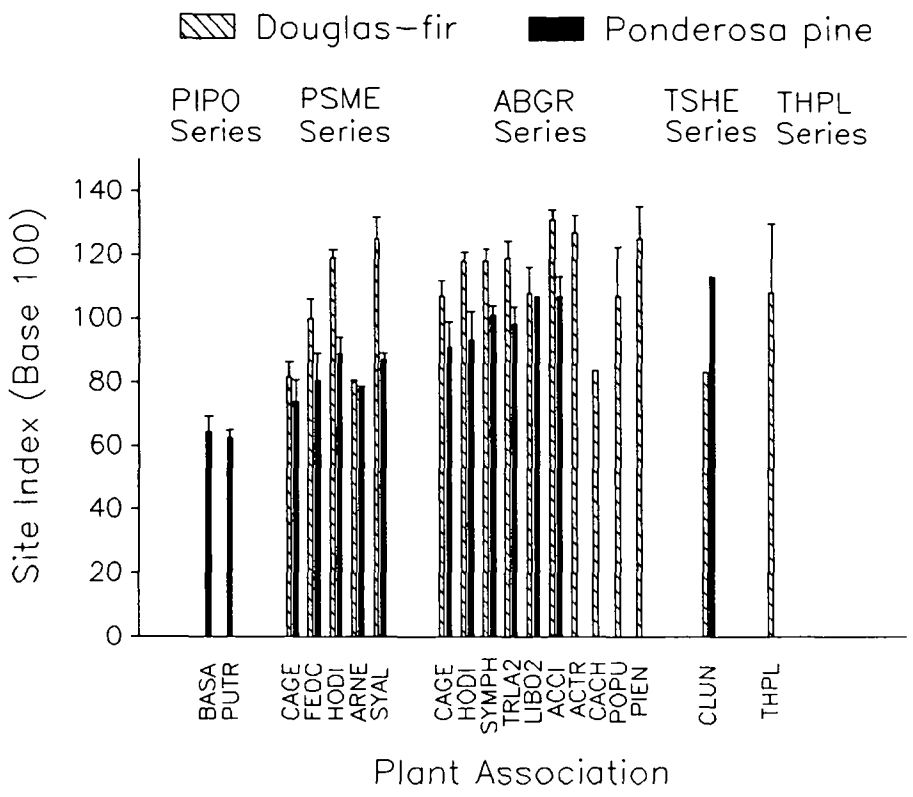


Figure 11a. Average site index, base age 100 years, for Douglas-fir (Curtis et al. 1974) and ponderosa pine (Barrett 1978). The narrow bars indicate the mean plus one standard error of the mean. See Table 1 for key to association codes.

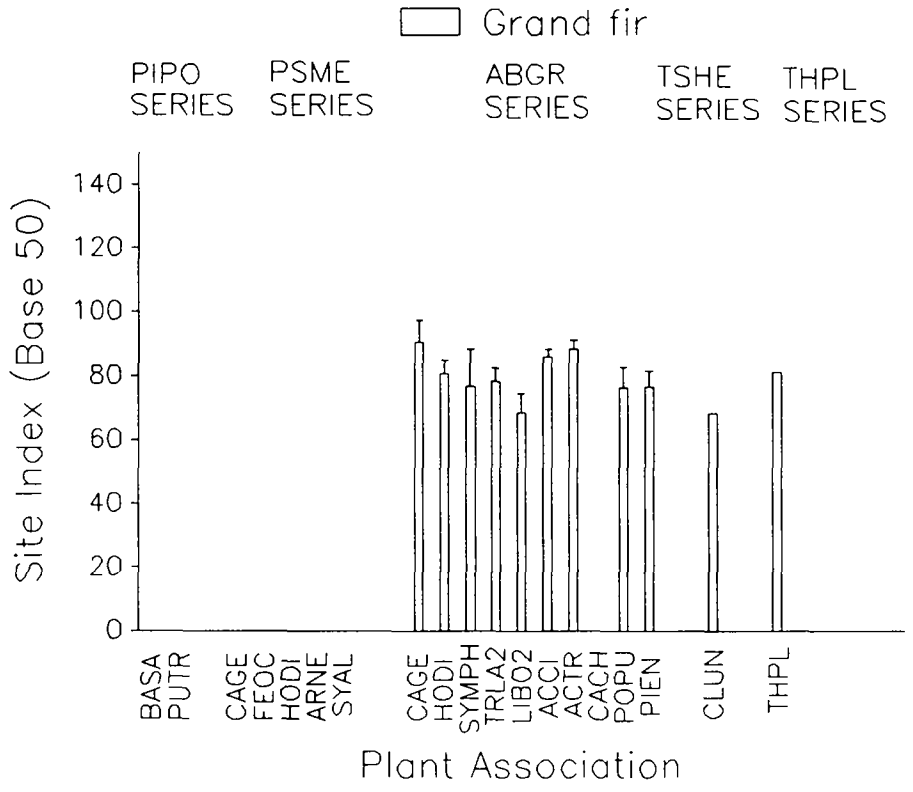


Figure 11b. Average site index, base age 50 years, for Grand fir (Cochran 1979). The narrow bars indicate the mean plus one standard error of the mean. See Table 1 for key to association codes.

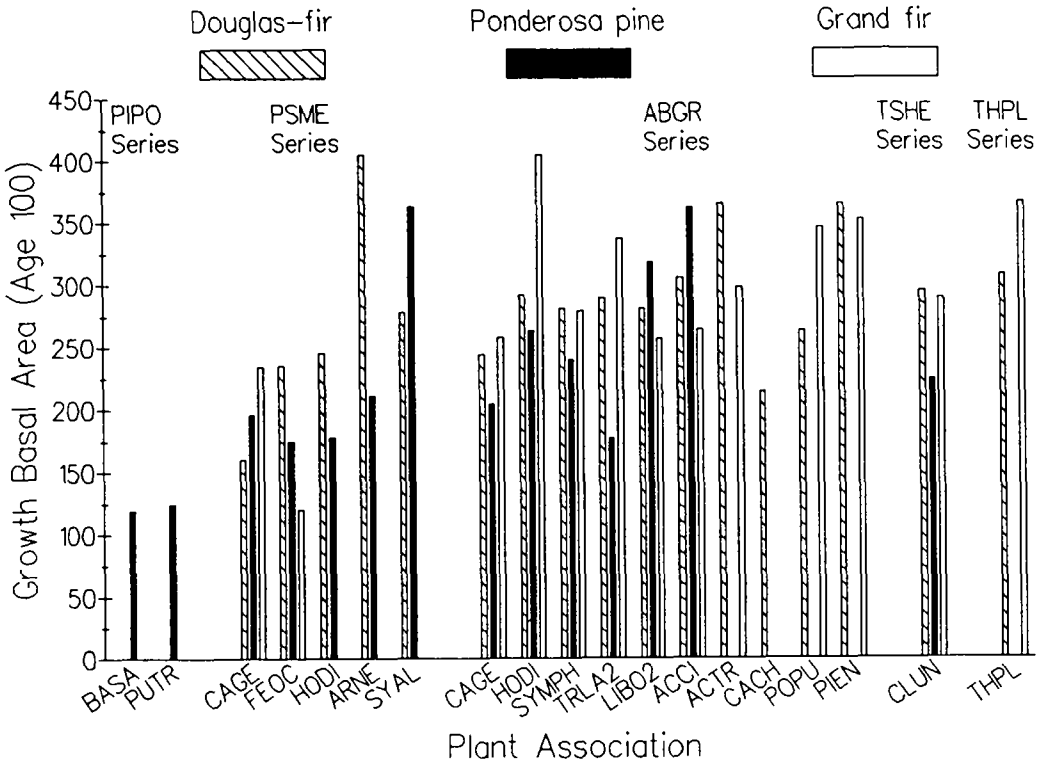


Figure 12. Average growth basal area for each plant association, indexed to 100 years, for Douglas-fir, ponderosa pine, and grand fir. Growth basal area (Hall 1988) is a stockability index. It is that basal area at which dominant trees have one inch per decade radial growth. See Table 1 for key to association codes.

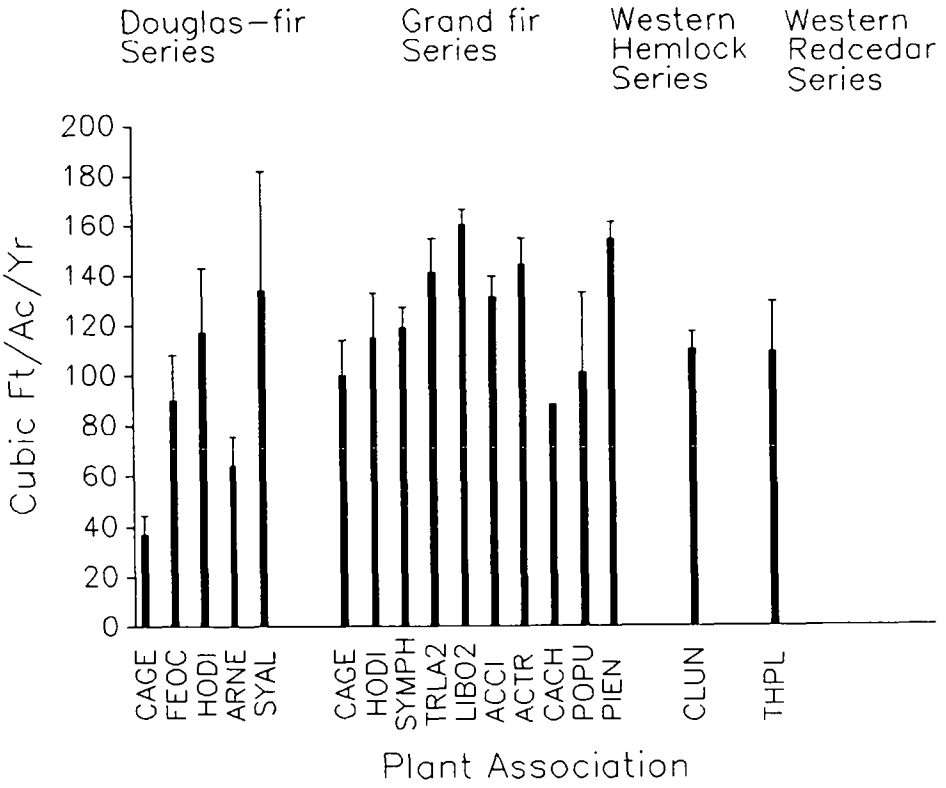


Figure 13. Average index of potential timber yield at culmination of mean annual increment for each plant association. The narrow bars indicate the mean plus one standard error of the mean. See Table 1 for key to association codes. The plot values are based on site index derived yield tables which are adjusted for percent of "normal" stocking as defined by stand density index measurements (Reineke 1933).

Long-Term Site Productivity

Long-term site productivity refers to the ability of a site to continue to produce, during the course of multiple harvest rotations, biological products as well as maintain ecosystem functions. Biological production includes timber production as well as the maintenance of individuals of many species (biological diversity). Ecosystem functions include energy, nutrient, and hydrological cycling. Rates and efficiencies of these cycles determine the ability of an ecosystem to convert light into biomass (photosynthesis), reduce erosion, maintain and enhance soil organic matter and nutritional status, and maintain stream flows.

Plant associations vary considerably in their resilience to management-caused disturbances. The association description text highlights those associations most sensitive to such detrimental effects as soil compaction, loss of surface and soil organic matter and depletion of ecosystem nutrients. Because timber management in this area is still primarily harvesting sites for the first time, we have to make extrapolations regarding possible detrimental effects of various management practices. Heavy equipment used in logging operations and slash piling, and nutrient depletion from slash burning, may result in long-term reductions of site potential. It is possible our stand management practices, such as excluding natural underburning and reducing plant species diversity, may adversely affect timber productive potential and increase susceptibility to pest outbreaks.

Silviculture

We have summarized various silvicultural concerns in Table 2. Our recommendations for activities appropriate for different associations are based on observation and interpretation of environmental gradients indicated by the associations. As we acquire more management experience of the response of different associations to treatments, our prescription ability will increase. The association descriptions include more explanatory text concerning these management concerns. A great deal of pertinent and useful silvicultural information is presented by Seidel and Cochran (1981). Details regarding those critical reforestation pests, pocket gophers, are reported by Teipner et al. (1983).

Snags and Fallen Trees

Recent research has increasingly pointed out the importance of snags and fallen trees as habitat for a myriad of organisms having important ecosystem roles. Snags in the Blue Mountains of Oregon provide habitat for 62 species of cavity-dwelling birds and mammals (Thomas et al. 1979). In their publication, "The Seen and Unseen World of the Fallen Tree", Maser and Trappe (1984) emphasize down logs as important habitat for nitrogen-fixing bacteria, many wildlife species, fish, and in-stream invertebrates. Fallen trees are also important rooting substrates and provide structure which aids stream stability and habitat quality. Down logs are now known to be vital to soil properties (Harvey et al. 1987), particularly in sites having poor nutritional status, such as most of this study area (see soils discussion). In their paper summarizing years of research in Inland Northwest forests fairly similar to the eastern portion of the Mt. Hood National Forest, Harvey et al. (1987) state: *"Our studies show that quantities of organic matter and their distribution, especially decaying wood and humus, have integral and sometimes critical roles to play in supporting the growth of forest trees".*

Snags and Fallen Trees: relationship with plant association groups

We have summarized our snag and fallen tree data by groups of plant associations representing substantially different portions of the environmental gradient. Douglas-fir series associations, indicating hot and dry environments, comprise the first group. We split the grand fir series into three groups: dry associations, mesic associations, and cold (also moist) associations. The moist, yet fairly warm, western hemlock and western redcedar associations comprise the fifth group. We did no intensive plots on our ponderosa pine series plots so we lack snag and down log data there.

There are many snags in the study area, except for the Douglas-fir series, but few are sufficiently large to be useful to wildlife and be likely to persist for very many years (Table 3). Figure 14 shows that by far most snags in all association groups are less than 20 inches at breast height. Large diameter snags (30 in. DBH) and tall snags (50 feet tall, see Figure 15) are most abundant in the cold grand fir zone associations. Most sampled snags were not very decomposed (decay classes 1 and 2, see Table 4). This result may reflect the preponderance of grand fir, a species which decomposes rapidly and is unlikely to remain standing when in the more highly decomposed condition classes. The low number of highly decayed snags may also be due to salvage operations, though we attempted to sample sites lacking such disturbances. The average snag DBH data reveal larger average diameters at both the dry and moist ends of the environmental sprectrum. The large diameters for the western redcedar and western hemlock group may indicate a high productive potential for individual trees. The large diameters for the Douglas-fir series may be

Table 2. Summary of some silvicultural characteristics of the plant associations of the Mt. Hood National Forest ponderosa pine, Douglas-fir, grand fir and eastside western hemlock and western redcedar series. See Table 1 for the English association names corresponding to these acronyms and Table 8 for the complete common and Latin species names.

Plant Association	Relative Regeneration hazard: Brush Competition	Drought Hazard	Gopher potential	Suitable Species: Planted	Natural Regeneration
		Ponderosa Pine Series			
PIPO-QUGA/BASA	minimal	severe	moderate	none	PIPO,QUGA
PIPO-QUGA/PUTR	brushland	severe	moderate	none	PIPO,QUGA
		Douglas-fir Series			
PSME/CAGE	moderate	severe	severe	PIPO	PIPO,PSME
PSME/FEOC	moderate after soil disturbance	high	severe	PIPO	PIPO,PSME
PSME/HODI/CAGE	severe (HODI, AMAL, CEVE,CEIN)	high	moderate	PIPO	PIPO,PSME
PSME/ARNE	severe (CACH,HODI)	high	low	PIPO	PIPO,PSME
PSME/SYAL	severe (SYAL,CEVE HODI,CEIN)	high	high	PIPO	PIPO,PSME
		Grand Fir Series			
ABGR/CAGE	moderate (AMAL,HODI CEVE,CEIN)	high	severe	PIPO	PIPO,PSME
ABGR/HODI	severe (HODI,AMAL CEIN,CEVE	high	moderate	PIPO	PSME,PIPO
ABGR/SYMPH	moderate after hot burns(CEVE)	high	moderate	PIPO	PSME,PIPO

Table 2. (Cont.)

Plant Association	Relative Regeneration hazard: Brush Competition	Drought Hazard	Gopher potential	Suitable Species: Planted	Natural Regeneration
		Grand Fir Series (cont.)			
ABGR/TRLA2	only after hot burns (CEVE)	medium	severe if slope < 15	PIPO, PSME	PIPO,PSME ABGR
ABGR/LIBO2	moderate after hot burns (CEVE)	medium	severe if slope < 15 %	PIPO & PSME in cc's & sh's	PSME,PIPO ABGR some LAOC possible
ABGR/ACCI/ACTR	likely (CEVE,CEIN ACCI,SYNO)	medium	high	PSME LAOC PIPO	PSME,PIPO LAOC ABGR
ABGR/ACTR	severe if burned hot (CEVE)	medium	severe	PSME PIPO LAOC	PSME,LAOC ABGR some PIMO possible
ABGR/CACH	moderate (CACH)	medium	moderate	PSME LAOC PIMO	PSME,ABGR LAOC, PIMO
ABGR/POPU	low	low	severe if slope < 15 %	PIEN LAOC ABPR PIMO	ABGR,PIEN LAOC,PSME PIMO,ABPR
ABGR-PIEN/SMST	low	low	severe	PIEN ABPR LAOC PIMO	ABGR,PIEN LAOC,ABPR PIMO,PSME
		Western Hemlock Series			
TSHE-ABGR/CLUN	low	low	moderate	PSME	PSME,ABGR LAOC, PIMO
		Western Redcedar Series			
THPL-ABGR/ACTR	low	low	moderate	PSME LAOC PIMO	PSME,ABGR LAOC,PIMO PIEN

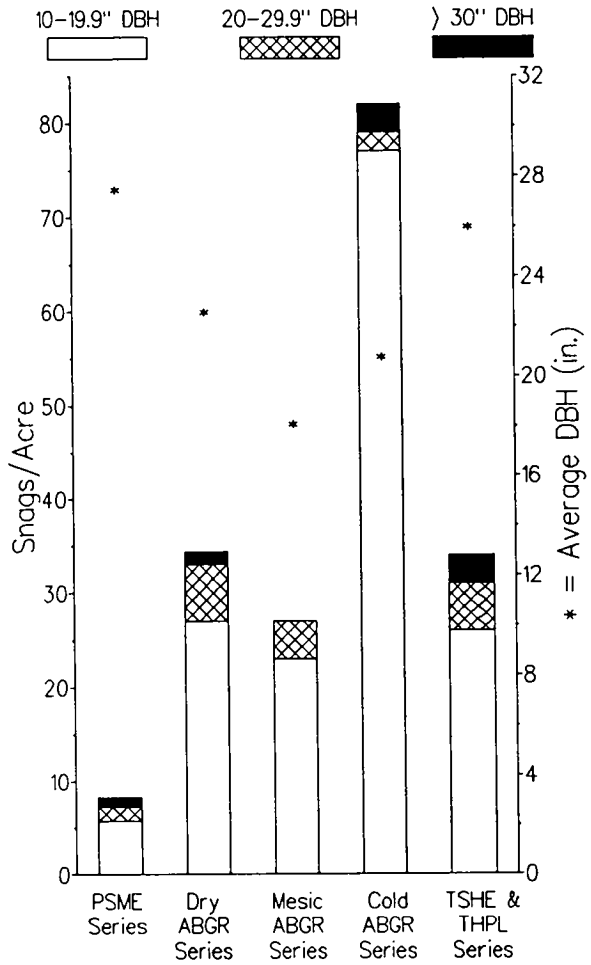


Figure 14. Average number of snags per acre by diameter class and the average snag diameter for each of five association groups. See Table 1 for key to association codes. The dry grand fir series includes ABGR/CAGE, ABGR/HODI, ABGR/SYMPH, ABGR/TRLA2, ABGR/LIBO2, and ABGR/CACH associations. The mesic grand fir series includes ABGR/ACCI/ACTR and ABGR/ACTR associations. The cold grand fir series includes ABGR-PIEN/SMST and ABGR/POPU associations. Snag data are unavailable for the ponderosa pine series.

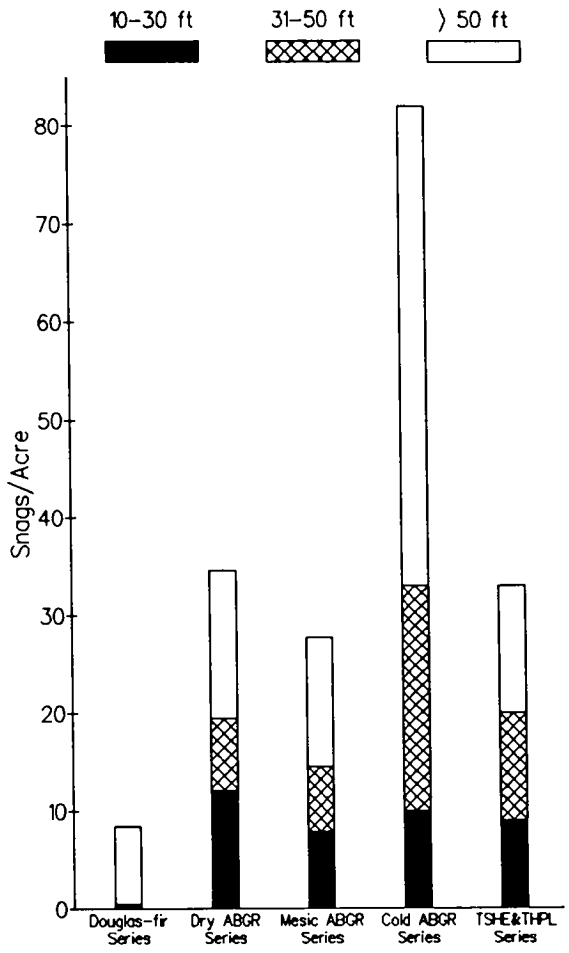


Figure 15. Average number of snags per acre by height class for each of five association groups. See Table 1 for key to species codes and Figure 14 for a list of associations within each series grouping.

due to the occurrence of a few large snags and the relative paucity of small-diameter snags which bring the group average down.

The total amount of down woody debris increases directly with the environmental gradient from a low in the Douglas-fir series to a high in the western hemlock and western redcedar series (see Tables 3 and 5 and Figure 16). The association groups also show differing patterns of down wood accumulations by both diameter size classses and decay condition classes (Table 5). The percentage of fairly fresh down material (decay condition 1) is much higher in the Douglas-fir series than in the western hemlock and western redcedar series. This pattern may reflect the past fire history of these sites. The dry Douglas-fir series sites very likely experienced presettlement fires every 20 years or so whereas the moist, valley bottom sites typical for the western hemlock and western redcedar series probably had much longer fire return periods. Such fires would have large impacts on the abundance and composition of down wood. The total amounts and relative distribution among the size classes of down wood also reflect fire history as well as site productive potential. The cold grand fir series and western hemlock and western recedear associations have much more large down material and this large material is a much larger percentage of the site total than in the other, drier association groups.

Snags and Fallen Trees: relationship with stand seral stage

We have also stratified our snag and fallen tree data by site seral stage. These stages are based on the ages of the oldest prevalent tree layer, either early seral (30-100 years), mid seral (100-200 years) or late seral (200 years). The seral stages have, at most, subtle differences in the amount and type of snags we sampled (Table 6).

Table 3. Summary data for snags, down woody material and fine fuels by groups of plant associations. Means and standard error of the mean (in parentheses) are presented. See Table 1 for key to species codes. The dry grand fir series includes ABGR/CAGE, ABGR/HODI, ABGR/SYMPH, ABGR/TRLA2, ABGR/LIBO2, and ABGR/CACH associations. The mesic grand fir series includes ABGR/ACCI/ACTR and ABGR/ACTR associations. The cold grand fir series includes ABGR-PIEN/SMST and ABGR/POPU associations. Data are unavailable for the ponderosa pine series.

Association Group	# Samples	Snags/acre TOTAL	Snags/acre > 50' tall & ≥ 20" DBH	Snags/acre 30-50' tall & ≥ 20" DBH	Average Snag DBH	Total Down Woody Debris Volume FT^3/AC	Total Down Woody Debris Weight Ton/Ac	Total Down Woody Debris Number Per Ac	Fine Fuels Tons/Ac <1/4in.	Fine Fuels Tons/Ac 1/4-1 in.	Fine Fuels Tons/Ac 1-3 in.
Douglas-fir series	17	9 (6)	2 (2)	1 (1)	27 (6)	402 (86)	4.29 (.94)	214 (44)	.48 (.08)	1.47 (.18)	1.44 (.22)
Dry Grand fir series	42	34 (6)	2 (1)	5 (2)	23 (2)	906 (112)	9.35 (1.16)	300 (40)	.74 (.07)	2.27 (.14)	2.66 (.27)
Mesic Grand fir series	13	28 (8)	5 (3)	0 (0)	18 (3)	1183 (316)	12.7 (3.47)	267 (47)	.87 (.06)	2.42 (.25)	3.66 (.57)
Cold Grand fir series	7	82 (27)	3 (2)	2 (2)	21 (3)	1493 (610)	16.2 (6.75)	259 (111)	.80 (.07)	2.31 (.28)	2.33 (.74)
Western hemlock & Western redcedar series	5	33 (14)	5 (3)	2 (2)	26 (4)	2625 (760)	26.2 (7.12)	376 (100)	.65 (.10)	1.78 (.61)	3.40 (.64)

Table 4. Mean and standard error of the mean (in parentheses) number of snags per acre by height, decay condition class (defined in the text), and diameter class for groups of plant associations. See Table 1 for key to species codes and Table 3 for a list of associations within each series grouping.

Association Group	# Samples	Height Class (ft.)			Decay Condition Class					Diameter Class (DBH in.)			
		10-30	31-50	>50	1	2	3	4	5	10-19"	20-29	30-39	>40
Douglas-fir series	17	1 (1)	0 (0)	8 (6)	5 (3)	3 (3)	0 (0)	1 (1)	0 (0)	6 (5)	2 (1)	1 (1)	0 (0)
Dry Grand fir series	42	12 (3)	7 (3)	15 (5)	17 (5)	8 (2)	5 (2)	2 (1)	4 (2)	27 (6)	6 (2)	1 (0)	0 (0)
Mesic Grand fir series	13	8 (4)	7 (5)	13 (6)	16 (6)	3 (3)	4 (2)	3 (3)	2 (2)	23 (8)	4 (3)	0 (0)	0 (0)
Cold grand fir & spruce series	7	10 (6)	23 (21)	49 (21)	49 (20)	28 (14)	0 (0)	5 (4)	0 (0)	77 (28)	2 (2)	3 (2)	1 (1)
Western hemlock & western redcedar series	5	9 (6)	11 (5)	13 (10)	15 (6)	17 (11)	1 (1)	0 (0)	0 (0)	26 (12)	5 (2)	3 (3)	0 (0)

Table 5. Mean and standard error of the mean (in parentheses) weight and number of pieces per acre of down woody material by diameter size class and decay condition class (defined in the text) for groups of plant associations. See Table 1 for key to species codes and Table 3 for a list of associations within each series grouping.

Association Group	# Samples	Diameter Size Class								Decay Condition Class					
		<6"		6-11"		12-19"		>20"		1		2		3	
		Tons/Ac	#/Ac	Ton/Ac	#/Ac	Tons/Ac	#/Ac	Tons/Ac	#/Ac	Tons/Ac	#/Ac	Ton/Ac	#/Ac	Ton/Ac	#/Ac
Douglas-fir series	17	1.4 (0.4)	185 (42)	1.1 (0.4)	25 (9)	.6 (.3)	2 (1)	1.2 (0.8)	1.6 (1.1)	.8 (0.8)	7 (4)	1.5 (0.4)	72 (22)	2.0 (0.7)	134 (37)
Dry grand fir series	42	2.2 (0.3)	251 (39)	2.7 (0.4)	39 (6)	2.5 (0.5)	8 (2)	1.9 (0.6)	2.2 (.8)	.9 (0.3)	34 (8)	4.5 (0.7)	134 (20)	3.9 (0.7)	132 (29)
Mesic grand fir series	13	1.8 (0.4)	205 (39)	3.5 (1.1)	52 (15)	2.5 (1.1)	7 (3)	4.9 (2.8)	4.3 (2.2)	1.2 (0.7)	16 (6)	8.8 (3.0)	159 (36)	2.8 (.91)	92 (21)
Cold grand fir & spruce series	7	2.2 (1.1)	187 (97)	5.2 (1.7)	63 (21)	3.0 (1.9)	5 (3)	5.8 (3.9)	3.3 (2.3)	3.5 (2.5)	13 (5)	10.3 (3.6)	204 (89)	2.3 (1.3)	42 (28)
Western hemlock & western redcedar series	5	2.2 (0.7)	246 (71)	5.0 (1.2)	80 (28)	7.8 (2.9)	33 (16)	11.2 (5.2)	18 (8.6)	2.4 (1.7)	19 (11)	8.8 (3.7)	170 (77)	15.0 (7.7)	187 (114)

Table 6. Quantity (mean and standard error of the mean (SE)) of snags per acre by seral stage, decay condition class (defined in text), height class, and diameter (breast height) class.

		early seral (30-99 yrs.)		mid seral (100-200 yrs.)		late seral (>200 yrs.)	
		mean	SE	mean	SE	mean	SE
decay condition	1	15	5	21	7	14	6
	2	4	2	12	4	12	8
	3	4	2	2	1	3	2
	4	2	1	3	2	1	1
	5	4	2	1	1	0	0
Height class	10-30'	10	3	7	3	8	5
	31-50'	3	2	10	4	14	10
	>50'	15	5	22	7	8	5
DBH class	10-19"	24	6	30	7	25	13
	20-29"	3	1	7	2	2	1
	30-39"	1	0	2	1	3	1
	>40"	.1	.9	.3	.	1	.
average DBH	inches	19.6	2	22.1	2	31.7	4
#cavities/ac		1.2	.5	1.3	.6	1.2	1.2
#large snags/ac (≥20"DBH and >50' tall)		2	1	3	1	4	2
#large snags/ac (≥20"DBH and 31-50'tall)		2	1	5	2	1	1
total snags/ac		29	6	39	8	30	14
# samples		39		30		14	

The late seral stands have the largest diameter snags (31.7 in. DBH). The number of large, tall snags, which provide the highest quality habitat for a diverse array of wildlife, was fairly similar among the three seral stages as was the average number of cavities per acre. The distribution of sizes and decay condition classes of down woody material also show only weak relationships to differing seral stage (Table 7). This lack of clarity may be due to the lack of evenness in the distribution of differing types of sites in the seral stages we sampled. Late seral stands are very uncommon in the study area. A chronosequence approach, in which the data are compared from very similar sites differing only in their age, would be a better way to ascertain trends in the development and decay of snags and down wood over time.

Table 7. Down woody material weight and number of pieces per acre (mean and standard error of the mean (SE)) by stand seral stages, size classes, and decay condition.

		early seral (30-99 yrs.)		mid seral (100-200 yrs.)		late seral (>200 yrs.)	
		mean	SE	mean	SE	mean	SE
Diameter size class							
	<6" Ton/Ac	2.0	.2	2.1	.4	1.6	.5
	#/Ac	211	23	263	52	177	50
	6-11" Ton/Ac	2.8	.5	2.9	.5	2.7	.9
	#/Ac	39	7	53	9	26	7
	12-19" Ton/Ac	1.8	.5	3.0	.7	3.3	1.4
	#/Ac	5	2	10	3	10	5
	≥20" Ton/Ac	1.6	.5	5.3	1.8	2.5	1.5
	#/Ac	2	1	5	2	3	2
Decay condition class							
	1 Ton/Ac	.9	.3	1.1	.6	2.5	1.2
	#/Ac	22	6	18	6	37	14
	2 Ton/Ac	4.5	.9	7.0	1.4	3.7	1.7
	#/Ac	119	19	163	29	106	35
	3 Ton/Ac	2.8	.6	5.2	1.5	4.0	1.9
	#/Ac	116	21	151	40	73	24
Total Down Woody Debris							
Volume (ft^3/Ac)		782	125	1294	214	953	323
Weight (Ton/Ac)		8.2	1.4	13.3	2.2	10.2	3.3
Number/Ac		258	26	332	55	216	55
# Samples		39		30		14	

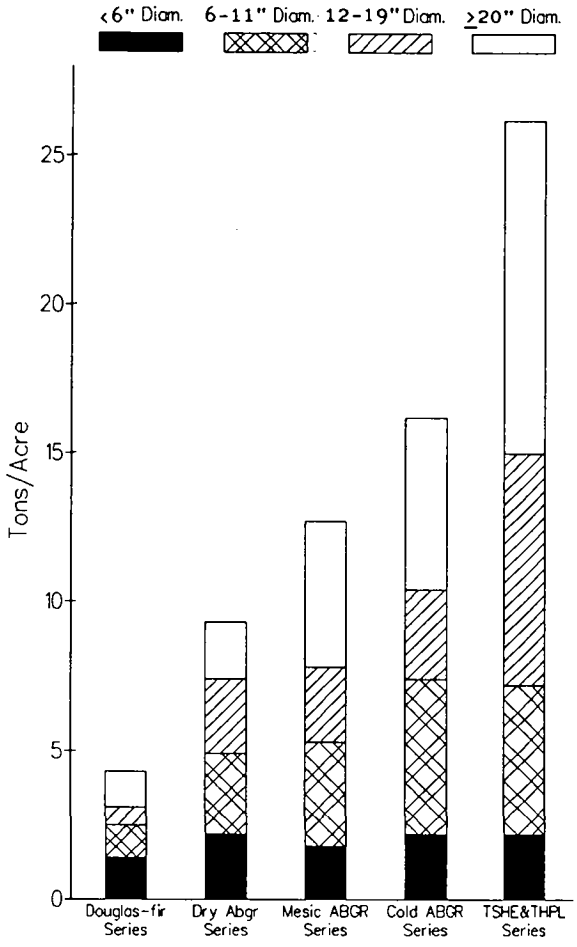


Figure 16. Average weight of down woody material by diameter class for each of five association groups. See Table 1 for key to species codes and Figure 14 for a list of associations within each series grouping.

Management of Snags and Fallen Trees

During the recent past our concern for the importance of snags and down woody material as wildlife habitat has resulted in specific management standards. The draft Forest plan for the Mt. Hood National Forest includes these standards:

"Dead and defective tree habitat, i.e. a minimum of 4 snags per acre, shall be provided in perpetuity with sufficient habitat improvement quality, quantity, and distribution to maintain dependent species at, or about 60% of their potential population capacity".

"A minimum of two down logs per acre, each over 40 cubic feet in gross volume, shall be maintained". (Examples of 40 cubic foot logs: 12 inch diameter by 36 ft long; 18 in. by 20 ft.; 24 in. by 12 ft.)

The Blue Mountain wildlife book (Maser et al. 1979) suggests a number of management guidelines for down woody material. Our study area has somewhat similar habitats as portions of the Blue Mountains. Some of these guidelines are:

- Woody debris should be retained for wildlife cover on 10% of the area clearcut;
- Slash should be reduced to a depth of 8 inches or less on at least 75% of an area with an established priority for livestock grazing and untreated slash should be retained as wildlife habitat on 25% of the area;
- Continuous concentrations of slash should be avoided because they restrict the travel of big game;
- At least 2 uncharred class 1 or 2 logs per acre and all class 3, 4 and 5 class logs should be retained as wildlife habitat.

Our data, obtained from fairly undisturbed sites, indicate that these standards may be difficult to attain in some forest series. In the Douglas-fir series we found only 3 snags per acre which were greater than 30 feet tall and larger than 20 inch diameter (see Table 3). Although most snags were in the relatively sound decay classes (see Table 4), it is likely that individual snags do not persist long enough to remain standing or useable as wildlife habitat through an entire 80 to 150 year rotation. Ponderosa pine, Douglas-fir or western larch are the most desirable snag species because of their ability to persist several decades. Grand fir snags decay much more rapidly. Forest managers will have to leave live trees in harvest units to provide future snags if the management standards are to be met. Uneven-aged forest management techniques should become increasingly useful to attain the desired forest conditions and still allow timber harvest.

Large down logs are also sparse in the Douglas-fir series and the dry portion of the Grand fir series (see Table 5). These areas have fairly low timber productivity and they probably have experienced frequent fires before the advent of aggressive fire suppression. Harvest activities and fuels treatments will require careful attention to down logs if future stands are to include desirable quantities, quality, and distribution of woody debris.

A comparison of the snag and down woody material data from this study with those reported from the western hemlock zone (Halverson et al. 1986) indicates that management of this material will be much more of a challenge on our eastside forests than the moist, more productive westside. Similar measurement and analysis methods were used for both reports. The western hemlock zone had generally 2-3 times more snags and down logs than the Douglas-fir and dry grand fir series associations.

Wildlife and Range

Deer, elk, western ground squirrels and Merriam's wild turkey have been selected by planners as management indicator species on the eastern portion of the Mt. Hood National Forest because of their visibility, popularity as game, and their dependence on ponderosa pine-Oregon white oak habitat. The health and abundance of populations of these species are thought to be indicators of the impacts of management activities on overall ecosystem functions.

Overall habitats and flora are fairly similar between this study area and the northern portion of the Blue Mountains of Oregon and Washington. The plant associations described are also fairly similar (Hall 1973). Many of the management recommendations included in the Blue Mountains wildlife book (Thomas 1979) are appropriate here as well.

Deer and Elk

There is a large body of literature and knowledge regarding these important game and "watchable" wildlife species. Individual plant association descriptions in this publication include discussion of the forage, winter range value and stand-structure components important to deer and elk.

Winter forage and thermal protection are critical habitat elements for deer and elk. Because winter forage is so critical, range condition is particularly important in low snow-fall areas. Knowledge of plant associations can aid in determining the general climatic setting of sites and evaluations of their winter range value. The ponderosa pine series associations remain snow-free for much of winter. Furthermore, the abundant grasses and bitterbrush in these associations are extensively utilized by ungulates during winter and spring. Ideal winter habitats exist at low elevations on the Forest where Douglas-fir series associations blanket north aspects and ponderosa pine series associations lie on the adjacent south-facing slopes. The Douglas-fir series sites generally can support dense timber which provides vital thermal protection. The nearby ponderosa pine/Oregon white oak stands which prevail on south-facing slopes provide forage and snow-free conditions for much of winter. Careful timber management of winter range provides for a useful mixture of thermal cover and foraging sites. The different plant associations have different timber growth and stockability, thus plant associations may aid in prescribing appropriate silviculture to provide necessary wildlife habitat.

Edges

One major concept emphasized in the Blue Mountains wildlife book (Thomas 1979), the value of "edge" and "edge contrast" between neighboring plant communities, is now being re-evaluated. The emphasis of "edge" as a surrogate measure for species diversity (Thomas et al. 1979) has been re-examined as we learn more regarding the landscape ecology of patches (eg. Franklin and Forman 1987). Recent work (eg. Lande 1988) emphasizes two possible negative effects of edges. First, there is a deterioration of habitat quality in the blocks of forest which are near the edges of openings. As more and more of our forest landscape is harvested, the sizes of remaining patches decreases as does their habitat integrity for forest-requiring species. The second negative edge effect concerns the increased failure rates of forest-requiring individuals which disperse into unsuitable habitats. We currently lack information regarding the crucial patch size of forests for various plant or animal species. It is clear that although edges may support more species than either openings or forests, many of these are disturbance-loving species which are abundant regionally. Regional species diversity may depend on the maintenance of some habitat representative of pre-settlement conditions.

Western Gray Squirrel

The western gray squirrel *(Sciurus griseus)* is restricted to sites having ponderosa pine and some Oregon white oak. The two ponderosa pine series associations provide the most important habitat for the western gray squirrel. The Douglas-fir series associations can also be utilized if Oregon white oak is maintained in the stand. This requires silvicultural manipulation because without stand-opening disturbance, sites in the Douglas-fir series will eventually support closed stands of conifers lacking Oregon white oak.

Recent research on and adjacent to the Mt. Hood National Forest (S. Foster, personal communication) has documented the habitat and diet of the western gray squirrel. The habitat used by the western gray squirrel includes a variety of mixed ponderosa pine/Oregon white oak forests ranging from fairly open, sparse stands to dense clusters of pole-sized trees which include some larger pines. There are always a few oak trees in the vicinity of nests. Almost all winter and breeding nests are in codominant ponderosa pine trees. Nests are never in lone trees: the squirrels require a continuous aerial canopy to allow movement away from their nests. In summer the squirrels utilize north aspects more than during the rest of the year and they make leaf nests in oak trees for loafing. Cover is crucial to protect the animals from predators: they do not utilize areas greater than 100 feet from cover. The squirrels are rarely found more than 1/4 mile from a water source.

Food sources on the Mt. Hood National Forest are fairly similar to those utilized in northern California (Stienecker and Browning 1970). Oak acorns, pine cones, hypogeous (subterranean, eg. truffles) fungi and various berries form the bulk of diets. Other foods include snowberry, oceanspray, wild rose, hazel, and bitter cherry. Acorn production appears to be highly variable year to year, though few data are available in the Northwest. A study in the Willamette valley (Coblentz 1980) found greater production in open, savannah stands than in closed canopy stands, yet each of the 3 crop years sampled were very different (range: 0 to 525 kg/ha in the closed canopy stand). Acorn production on the eastern portion of the Mt. Hood National Forest may be even more variable and probably is much lower in total amount because of the lower abundance and smaller size of the oak trees.

There are several wildlife species which utilize the same foods as the western gray squirrel. Of particular concern are Merriam's turkey (introduced to Oregon in 1961) and deer. The turkeys have considerable dietary overlap with the squirrels, including the use of acorns and pine nuts. Deer also eat acorns preferentially and are adept at foraging for hypogeous fungi. Management activities which help sustain large populations of turkeys and deer may be detrimental to western gray squirrel populations. Timber manipulations which leave stands too open for squirrel movement or which lead to the reduction of oak or ponderosa pine can also be detrimental to gray squirrels.

Several management recommendations to maintain and enhance western gray squirrel habitat follow (S. Foster, personal communication):

- Maintain a contiguous airborne (tree canopy) route for about 200 yards around nests.
- Maintain a component of large oak and ponderosa pine for both food production and structural habitat.
- Focus habitat concerns within 1/4 mile of water and increase potential habitat by building watering structures further from streams.
- Plant mast-bearing plants such as California hazel. Hazel can grow in the Douglas-fir series associations as can Oregon white oak and ponderosa pine.
- Do not create islands of habitat; set-up and maintain corridors of habitat and leave snags in clusters.
- Do not make large timber harvest openings in potential squirrel habitat; make openings no wider than 200 feet.

Merriam's Wild Turkey

Merriam's wild turkey *(Meleagris gallopavo merriami)* were introduced on the eastern portion of the Mt. Hood National Forest in 1961 (Lutz 1983). They have since become established and are an important game bird. This species is highly mobile, utilizing much of the eastern portion of the Mt. Hood National Forest for at least part of the year. Wintering habitat is critical (Crawford and Lutz 1984). Untreated slash in thinned, mixed conifer (ponderosa pine, Douglas-fir and grand fir) stands makes ideal nesting habitat (Crawford and Lutz 1984).

Recent analysis of Merriam's wild turkey roost sites in our area has demonstrated the importance of mature grand fir series association forests throughout the year (Lutz and Crawford 1987). These stands correspond to what Lutz and Crawford (1987) term "mixed conifer cover type". Some roosting also occurred in Douglas-fir series association sites (Lutz and Crawford's ponderosa pine/Douglas-fir/white oak cover type) and in ponderosa pine series associations (Lutz and Crawford's ponderosa pine/white oak cover type). Though available in much smaller amounts, several cover types were not used for roosting: Oregon white oak, thinned mixed conifer, young mixed conifer, old and recent clearcuts, shelterwoods, and mixed deciduous stands. Winter roost sites were at lower elevations, almost always on north aspects, and were generally more steep than roost sites used during other seasons. Winter roost site selections may be heavily influenced by the scarcity of the preferred mature mixed conifer stands because of extensive past timber harvest of such sites on more gentle ground at low elevations (Lutz and Crawford 1987).

Crawford and Lutz (1984) presented the following management recommendations to enhance Merriam's wild turkey habitat:

- Winter roost sites need to be protected. Ideal sites include dense conifer cover at low elevations. These sites primarily occur on north aspects. Many are likely to support the Douglas-fir/Western fescue plant association.
- Habitats should include an even distribution of mature, mixed conifer stands, older-aged oak stands, and early successional conifer stands.
- Forested and open habitats should be interspersed.
- Forested stands should be manipulated to have 20-30% overhead cover.
- Slash should be left untreated in some thinned mixed conifer stands to provide nesting areas.
- Some mature ponderosa pine should be maintained at low elevations to provide roosts.

Range

The eastern portion of the Mt. Hood National Forest was heavily used by both sheep and cattle before the Great Depression of the 1930's. Federal administration of this area began in 1893 with the General Land Office of the Department of Interior. Very little management was provided until the establishment of the Forest Reserves and the transfer of the Mt. Hood area to the jurisdiction of the U.S. Department of Agriculture in 1906. At that time there was also extensive settlement of the area adjacent to the eastern edge of federally managed lands. Several small towns and lumber mills existed in areas that currently lack settlement. The same grazing resource which attracted settlement was eventually displaced by the brushy vegetation and tree regeneration which encroached grazing lands following fire suppression activities. The reduction of grazing carrying capacity is due to this encroachment, to range damage from over-grazing, as well as a reduction of the land base available to livestock. Reductions in the grazing allotment land base began in the 1930's with the removal of The Dalles Watershed and the areas near Mt. Hood (because of recreational conflicts).

The abundant and dense stands of grand fir throughout much of the grand fir series is due to fire suppression. During pre-settlement times the vegetation on these sites included open, park-like forests and a patch-work of meadows and brush fields. A Forest service report in 1922 stated: *"Mixed with the timber, most of the entire area supports a dense stand of reproduction and brush. Snowbrush which has no forage value appears to be taking the range. It may be of interest to note that the old stockmen, who used the range 20 years ago, say that the area was an open timbered, grass and weed range with scarcely any reproduction or brush at that time"* (cited in Williams 1978). No doubt, underburning was a frequent visitor to forests of much of this area before 1900.

The legacy of over-grazing is still discernible. We still see abundant cheat grass and other annual grasses as the result of over-grazing along the major sheep drive-trails which connected the high elevation summer pastures with private lands east of the National Forest. There probably has been a general improvement in range condition following the great reduction in sheep grazing which occurred in the 1940's.

Livestock utilization on the study area is currently lower than at any other time this century. Today most livestock activities on the Mt. Hood National Forest are within the vegetation zones described in this publication. During 1988 the 10 permittees on the 6 active cattle allotments turned out 720 cattle (3726 AUM's). The lone sheep allotment was inactive. In 1983 the 9 allotments on the Forest were grazed by 1900 cattle (16 permittees with 5383 AUM's) and 850 sheep (1 permittee with 893 AUM's). In 1922, 4390 cattle (100 permittees) and 21,200 sheep (16 permittees) grazed the Mt. Hood National Forest, and in 1941, 1912 cattle (50 permittees) and 12,575 sheep (9 permittees) officially grazed (Range management work plan, Mt. Hood National Forest, February 27, 1942).

Most forage for livestock on the Mt. Hood National Forest is found in transitory range. Non-forest range lands are not at all abundant now that fire suppression has allowed trees to establish throughout most of the National Forest. Transitory range includes those areas where forage grows for a number of years during the successional transition of a site from grasses, herbs and shrubs following disturbance to closed forest with low range value. Transitory range abundance and quality is highly dependent on management activities. Clearcut timber harvests allow high forage productivity for a few years until timber regrows. The use of forage seed of non-native grasses and legumes can enhance forage productivity, but in the drier plant associations, such seeding can make reforestation extremely difficult. We are only beginning to evaluate the use of native forage species for seeding projects.

The plant association descriptions in this publication discuss the potential forage productivity for livestock of particular sites. We currently lack quantitative data regarding herbage production. However, in this area where transitory range is the rule, forage production is dependent on cultural treatment, successional status, as well as site potential related to plant associations. Future research will deal with forage production in transitory forest types and production following various silvicultural and fuels treatments, such as the underburning conducted in our pine/oak area.

Chapter 2

Keys to Forest Series and Plant Associations

How to Key Out Sites to Plant Association

The following keys are used to determine the plant association of relatively undisturbed, mature forest stands. A fairly homogeneous area should be used. Proximity to a road, stand edge or other phenomenon that would influence the vegetation should be avoided. A good plot configuration is a roughly circular area between 40 and 50 feet in radius.

After selecting the plot area, list all tree (canopy and regenerating), shrub, forb and grass species. Estimate each species' percent cover by projecting the total crown perimeter of plants to a plane surface and estimating the percent of the plot area covered. Use Appendix 2 as a guide for making percent cover estimates.

After thoroughly examining the plot area, begin with the Key to Forest Series. Then use the appropriate Key to Plant Associations being careful to read each couplet of choices completely and follow the number sequence for the more correct choice. Where your site seems to fit both couplets, work through both branches of the key.

Evaluate your answer by reading the association descriptions and checking the vegetation summary data in Appendix 1.

In some stands the canopy may be so dense that the understory may be severely limited. In such cases, relative dominance rather than actual percentages may be used to determine plant association.

Much forest-land has had sufficient ground disturbance to alter the understory plant composition. Be careful to check sample plots for skidding tracks or compacted areas which may have plants that increase with disturbance. Attempt to evaluate whether a plant is abundant because of its adaptation to the site or to the disturbance history. Elk sedge and chinkapin are two such increasers, which also occur in undisturbed sites. Familiarity with where different associations occur along environmental gradients will aid in making such interpretations.

NOTE: The Key is Not the Classification!

Before accepting the results of keying out an association, be sure the vegetation and site fit the association description and are consistent with the species tables in Appendix 1.

Key to Forest Series: *Mt. Hood NF: Barlow, Bear Springs and Hood River Ranger Districts*

1a Subalpine fir > 2% cover in understory and > 10% cover in overstory..... **Subalpine Fir Series**[1]
1b Not as above..... **2**

2a Mountain hemlock > 2% cover in understory or > 10% cover in overstory.... **Mountain Hemlock Series**[1, 2]
2b Not as above..... **3**

3a Pacific silver fir > 2% cover in understory or > 10% cover in overstory..... **Pacific Silver Fir Series**[2]
3b Not as above..... **4**

4a Western hemlock > 2% cover in understory or > 10% cover in overstory..... **Western Hemlock Series**[3]
4b Not as above..... **5**

5a Western redcedar > 2% cover in understory or > 10% cover in overstory..... **Western Redcedar Series** page 35
5b Not as above..... **6**

6a Grand fir > 2% cover in understory or > 10% cover in overstory..... **Grand Fir Series** page 34
6b Not as above..... **7**

7a Douglas-fir > 2% cover in understory or > 10% cover in overstory..... **Douglas-fir Series** page 35
7b Not as above..... **8**

8a Ponderosa pine > 2% cover in understory and > 10% cover in canopy..... **Ponderosa Pine Series** page 35
8b Not as above: Woodland or non-forest not yet described

1. Subalpine Fir and Mountain Hemlock Series classification in preparation, available in 1989.

2. See Plant Association and Management Guide for the Pacific Silver Fir Zone, Mt. Hood and Willamette NF's, 1982, Hemstrom and others.

3. See Plant Association and Management Guide for the Western Hemlock Zone, Mt. Hood NF, Halverson and others 1986 as well as Western hemlock series key that follows.

Key to Plant Associations: Grand Fir (ABGR) Series

Mt. Hood National Forest

1a Oceanspray (HODI) cover ≥ 10%: **Grand fir/Oceanspray (ABGR/HODI)...CWS5 31...Page 75**
1b Not as above **2**

2a Engelmann spruce (PIEN) seedlings present and PIEN overstory cover ≥ 10% & Starry solomonplume (SMST) cover ≥ 2%:
Grand fir-Engelmann spruce/Starry solomonplume (ABGR-PIEN/SMST)...CWC5 11...Page 107
2b Not as above **3**

3a Vanillaleaf (ACTR) + Starry solomonplume (SMST) cover ≥ 10% **9**
3b Not as above **4**

4a Elk sedge (CAGE) cover ≥ 10%: **Grand fir/Elk sedge (ABGR/CAGE)...CWG1 21...Page 71**
4b Not as above **5**

5a Skunk-leaved polemonium (POPU) cover ≥ 2%:
Grand fir/Skunk-leaved polemonium (ABGR/POPU)...CWF5 23...Page 103
5b Not as above **6**

6a Chinkapin (CACH) cover ≥ 5%: **Grand fir/Chinkapin (ABGR/CACH)...CWS5 33...Page 99**
6b Chinkapin (CACH) cover < 5% **7**

7a Oceanspray (HODI) cover ≥ 2%: **Grand fir/Oceanspray (ABGR/HODI)...CWS5 31...Page 75**
7b Not as above **8**

8a Vanillaleaf (ACTR) + Starry solomonplume (SMST) cover ≥ 2 % **9**
8b Not as above **10**

9a Vine maple (ACCI) cover ≥ 5%: **Grand fir/Vine maple/Vanillaleaf (ABGR/ACCI/ACTR)...CWS5 32...Page 91**
9b Vine maple (ACCI) cover < 5%: **Grand fir/Vanillaleaf (ABGR/ACTR)...CWF5 22...Page 95**

10a Common snowberry + Creeping snowberry (SYAL + SYMO) ≥ 10%:
Grand fir/Snowberry (ABGR/SYMPH)...CWS3 31...Page 79
10b Common snowberry + Creeping snowberry (SYAL + SYMO) < 10% **11**

11a Elk sedge (CAGE) cover ≥ 2%: **Grand fir/Elk sedge (ABGR/CAGE)...CWG1 21...Page 71**
11b Not as above **12**

12a Twinflower (LIBO2) ≥ 2%: **Grand fir/Twinflower (ABGR/LIBO2)...CWF3 21...Page 87**
12b Not as above **13**

13a Starflower (TRLA2) ≥ 2%: **Grand fir/Starflower (ABGR/TRLA2)...CWF5 21...Page 83**
13b Not as above **14**

14a Common snowberry + Creeping snowberry (SYAL plus SYMO) ≥ 2%:
Grand fir/Snowberry (ABGR/SYMPH)...CWS3 31...Page 79
14b Not as above...Go back to # 1 and use lower % values for decisions. If key still is not useful, look at the keys for the other eastside forest series.

Key to Plant Associations: Western Hemlock and Western Redcedar Series

Mt. Hood National Forest: Barlow, Bear Springs and Hood River Ranger Districts

1a Western hemlock (TSHE) ≥ 2% and Grand fir (ABGR) ≥ 2% cover in understory with Queencup beadlily (CLUN) present: **Western hemlock-Grand fir/Queencup beadlily (TSHE-ABGR/CLUN)...CHC3 11...Page 111**

1b Not as above 2

2a Western redcedar (THPL) ≥ 2% and Grand fir ≥ 2% cover in understory with Vanillaleaf (ACTR) present: **Western redcedar-Grand fir/Vanillaleaf (THPL-ABGR/ACTR)...CCF2 11...Page 115**

2b Not as above...Try key to other series or likely have Mountain hemlock or Subalpine fir series association, See forthcoming high elevation forest classification or Pacific silver fir zone guide.

Key to Plant Associations: Douglas-fir (PSME) Series

Mt. Hood National Forest

1a Pinemat manzanita (ARNE) cover ≥ 5%: **Douglas-fir/Pinemat manzanita (PSME/ARNE)...CDS6 62...Page 63**

1b Not as above 2

2a Elk sedge (CAGE) cover ≥ 10%: **Douglas-fir/Elk sedge (PSME/CAGE)...CDG1 41...Page 51**

2b Elk sedge (CAGE) < 10% 3

3a Oceanspray (HODI) over ≥ 2%: **Douglas-fir/Oceanspray/Elk sedge (PSME/HODI/CAGE)...CDS2 31...Page 59**

3b Not as above 4

4a Western fescue (FEOC) cover ≥ 2%: **Douglas-fir/Western fescue (PSME/FEOC)...CDG3 21...Page 55**

4b Not as above 5

5a Elk sedge (CAGE) cover ≥ 2%: **Douglas-fir/Elk sedge (PSME/CAGE)...CDG1 41...Page 51**

5b Not as above 6

6a Common snowberry (SYAL) cover ≥ 5%: **Douglas-fir/Common snowberry (PSME/SYAL)...CDS6 61...Page 67**

6b Not as above...Go to # 1 and use lower % cover values for decisions, if key is still not useful, try the Grand Fir series key.

Key to Plant Associations: Ponderosa Pine Series (PIPO)

Mt. Hood National Forest

1a Bitterbrush (PUTR) cover ≥ 5%: **Ponderosa pine-Oak/Bitterbrush (PIPO-QUGA/PUTR)...CPII2 12...Page 47**

1b Not as above 2

2a Arrowleaf balsamroot (BASA) cover ≥ 2%: **Ponderosa pine-Oak/Arrowleaf balsamroot (PIPO-QUGA/BASA)... 43**

2b Not as above...try key to another series. (CPII2 11)

Table 8. List of plant species common within the ponderosa pine, Douglas-fir and grand fir zones of the Mt. Hood N.F. See Garrison et al. (1976) for complete lists of the species codes and Hopkins and Rawlings (1985) for plant identification.

Species Code[1]		Scientific Name	Common Name	Indicator Value
TREES				
ABAM	*	*Abies amabilis*	Pacific silver fir	cool/moist
ABGR	*	*Abies grandis*	Grand fir	
ABLA2	*	*Abies lasiocarpa*	Subalpine fir	cold
ABPR	*	*Abies procera*	Noble fir	cool
ACMA		*Acer macrophyllum*	Bigleaf maple	
ALRU		*Alnus rubra*	Red alder	warm/moist
CADE		*Calocedrus decurrens*	Incense-cedar	dry
LAOC		*Larix occidentalis*	Western larch	
PIEN	*	*Picea engelmannii*	Engelmann spruce	
PICO		*Pinus contorta*	Lodgepole pine	
PIMO		*Pinus monticola*	Western white pine	
PIPO	*	*Pinus ponderosa*	Ponderosa pine	dry
POTR		*Populus tremuloides*	Quaking aspen	moist
POTR2		*Populus trichocarpa*	Black cottonwood	wet
PSME	*	*Pseudotsuga menziesii*	Douglas-fir	
QUGA	*	*Quercus garryana*	Oregon white oak	dry
TABR		*Taxus brevifolia*	Pacific yew	
THPL	*	*Thuja plicata*	Western redcedar	moist
TSHE	*	*Tsuga heterophylla*	Western hemlock	warm/moist
TSME	*	*Tsuga mertensiana*	Mountain hemlock	cold
SHRUBS				
ACCI	*	*Acer circinatum*	Vine maple	
ACGLD		*Acer glabrum var. douglassii*	Rocky mountain maple	warm
AMAL		*Amelanchier alnifolia*	Serviceberry	warm/dry
ARNE	*	*Arctostaphylos nevadensis*	Pinemat manzanita	hot/dry
ARPA		*Arctostaphylos patula*	Greenleaf manzanita	hot/dry
BEAQ		*Berberis aquifolium*	Tall oregongrape	warm/dry
BENE		*Berberis nervosa*	Dwarf oregongrape	
BERE		*Berberis repens*	Creeping hollygrape	hot/dry
CACH	*	*Castanopsis chrysophylla*	Golden chinkapin	
CEIN		*Ceanothus integerrimus*	Deerbrush ceanothus	
CEPR		*Ceanothus prostratus*	Squawcarpet ceanothus	hot/dry
CEVE		*Ceanothus velutinus*	Snowbrush ceanothus	
CHUM		*Chimaphila umbellata*	Prince's pine	
CHNA		*Chrysothamnus nauseosus*	Gray rabbitbrush	hot/dry
COCO2		*Corylus cornuta var. californica*	California hazel	
CONU		*Cornus nuttallii*	Pacific dogwood	
GASH		*Gaultheria shallon*	Salal	
HODI	*	*Holodiscus discolor*	Oceanspray	warm/dry
LOCI		*Lonicera ciliosa*	Trumpet honeysuckle	
NONE		*Nothochelone nemorosa*	Nothochelone	
PAMY		*Pachistima myrsinites*	Oregon boxwood	
PUTR	*	*Purshia tridentata*	Bitterbrush	hot/dry
RHDI		*Rhus diversiloba*	Poison oak	warm/dry
RILA		*Ribes lacustre*	Prickly currant	
RIVI		*Ribes viscocissimum*	Sticky currant	
ROGY		*Rosa gymnocarpum*	Baldhip rose	
RONU		*Rosa nutkana*	Nootka rose	warm/dry
RULA		*Rubus lasiococcus*	Dwarf bramble	cool/moist
RUPA		*Rubus parvifolius*	Thimbleberry	

Species Code[1]	Scientific Name	Common Name	Indicator Value
SHRUBS CONT.			
RUUR	*Rubus ursinus*	Trailing blackberry	
SASC	*Salix scouleriana*	Scouler willow	burned
SOSI	*Sorbus sitchensis*	Sitka mountain-ash	
SPBE	*Spirea betulifolia*	White spirea	
SYAL *	*Symphoricarpos albus*	Common snowberry	
SYMO *	*Symphoricarpos mollis*	Creeping snowberry	
SYMPH *	*Symphoricarpos spp.*	Snowberry	
VAME	*Vaccinium membranaceum*	Big huckleberry	cool
HERBS			
ACMI	*Achillea millefolium*	Western yarrow	
ACTR *	*Achlys triphylla*	Vanillaleaf	mesic
ADBI	*Adenocaulon bicolor*	Pathfinder	mesic
ALAC	*Allium acuminatum*	Tapertip onion	warm/dry
ANDE	*Anemone deltoidea*	Three-leaved anemone	cool/moist
ANOR	*Anemone oregana*	Oregon anemone	
ANRA	*Antennaria racemosa*	Raceme pusseytoes	
APAN	*Apocynum androsaemifolium*	Dogbane	disturbance
ARCO	*Arnica cordifolia*	Heartleaf arnica	
ARDI	*Arnica discoidea*	Rayless arnica	warm/dry
ARLA	*Arnica latifolia*	Mountain arnica	cool
ARMA3	*Arenaria macrophylla*	Bigleaf sandwort	
BASA *	*Balsamorhiza sagittata*	Arrowleaf balsamroot	hot/dry
CASC2	*Campanula scouleri*	Scouler's bellflower	
CAPU2	*Cardamine pulcherrima*	Slender toothwort	dry
CLRH	*Clarkia rhomboidea*	Common clarkia	dry
CLLA	*Claytonia lanceolata*	Springbeauty	
CLUN *	*Clintonia uniflora*	Queencup beadlily	cool
COPA	*Collinsia parviflora*	Littleflower collinsia	
COGR	*Collinsia grandiflora*	Bluetips collinsia	
COGR2	*Collomia grandiflora*	Large-flowered collomia	
COUM	*Comandra umbellata*	Common comandra	
DENU3	*Delphinium nuttallianum*	Upland larkspur	dry
DIHO	*Disporum hookeri*	Fairy bells	
ERGR	*Erythronium grandiflorum*	Yellow fawnlily, dogtooth violet	
FRVE	*Fragaria vesca*	Woods strawberry	
FRVI	*Fragaria virginiana*	Broadpetal strawberry	
FRLA	*Fritillaria lanceolata*	Checker lily, mission bells	
FRPU	*Fritillaria pudica*	Yellow fritillary	dry
GAAP	*Galium aparine*	Catchweed bedstraw	
GAAS	*Galium asperrimum*	Rough bedstraw	
GATR	*Galium triflorum*	Sweetscented bedstraw	
GOOB	*Goodyera oblongifolia*	Rattlesnake plantain	
HAEL	*Habenaria elegans*	Elegant rein-orchid	
HAUN	*Habenaria unalascensis*	Alaska rein-orchid	
HIAL	*Hieracium albiflorum*	White hawkweed	
HIAL2	*Hieracium albertinum*	Yellow hairy hawkweed	dry
HISC	*Hieracium scouleri*	Scouler's hawkweed	
HYCA	*Hydrophyllum capitatum*	Ballhead waterleaf	dry
LALA2	*Lathyrus lanszwertii*	Thickleaf peavine	
LANE	*Lathyrus nevadensis*	Nuttall's peavine	
LICO4	*Lilium columbianum*	Columbia lily	
LIBO2 *	*Linnaea borealis*	Twinflower	cool
LIGL	*Lithophragma glabra*	Smooth prairiestar	dry

Species Code[1]		Scientific Name	Common Name	Indicator Value
HERBS cont.				
LOMA		*Lomatium macrocarpum*	Bigseed lomatium	dry
LOTR		*Lomatium triternatum*	Nineleaf lomatium	dry
LUCA		*Lupinus caudatus*	Tailcup lupine	
LULE		*Lupinus leucophyllus*	Velvet lupine	dry
LUNA2		*Luina nardosmia*	Silvercrown luina	
MOPE		*Montia perfoliata*	Minerslettuce	
NEPA		*Nemophila parviflora*	Smallflower nemophila	
OSCH		*Osmorhiza chilensis*	Mountain sweet-cicely	mesic
OSPU		*Osmorhiza purpurea*	Purple sweet-cicely	moist
OSMOR		*Osmorhiza spp.*	Sweet-cicely	
PEEU		*Penstemon euglaucus*	Glaucous penstemon	dry
POGL		*Potentilla glandulosa*	Gland cinquefoil	
POPU	*	*Polemonium pulcherrimum*	Skunk-leaved polemonium	cool
PTAQ		*Pteridium aquilinum*	Bracken fern	
PYPI		*Pyrola picta*	Whitevein pyrola	
PYSE		*Pyrola secunda*	Sidebells pyrola	
SADO		*Satureja douglasii*	Yerba buena	
SESP		*Sedum spathulifolium*	Spatula-leaf stonecrop	hot/dry
SEST		*Sedum stenopetalum*	Wormleaf stonecrop	hot/dry
SMRA		*Smilacina racemosa*	False solomonseal	mesic
SMST	*	*Smilacina stellata*	Starry solomonseal	moist
TITR		*Tiarella trifoliata*	Coolwort foamflower	moist
TRLA2	*	*Trientalis latifolia*	Star-flower	
TROV		*Trillium ovatum*	trillium	
VASI		*Valeriana sitchensis*	Sitka valarian	moist
VIAM		*Vicia americanum*	American vetch	
VISA		*Vicia sativa*	Common vetch	
VIGL		*Viola glabella*	Pioneer violet	cool/moist
VISE		*Viola sempervirens*	Redwoods violet	
XETE		*Xerophyllum tenax*	Beargrass	cool/dry
GRASSES AND SEDGES				
AGSP		*Agropyron spicatum*	Bluebunch wheatgrsss	hot/dry
BRCA		*Bromus carinatus*	California brome	hot/dry
BRMO		*Bromus mollis*	Soft brome	
BRTE		*Bromus tectorum*	Cheatgrass brome	disturbance
BRVU		*Bromus vulgaris*	Columbia brome	cool/moist
CARU		*Calamagrostis rubescens*	Pinegrass	warm
CAGE	*	*Carex geyeri*	Elk sedge	harsh
ELGL		*Elymus glaucus*	Blue wildrye	
FEID		*Festuca idahoensis*	Idaho fescue	warm/dry
FEOC	*	*Festuca occidentalis*	Western fescue	mesic
FEOV		*Festuca ovina*	Sheep fescue, hard fescue	
KOCR		*Koeleria cristata*	Prairie Junegrass	
LUCA2		*Luzula campestris*	Common woodrush	
MEBU		*Melica bulbosa*	Oniongrass	mesic
POBU		*Poa bulbosa*	Bulbous bluegrass	disturbance
PONE		*Poa nervosa*	Wheeler bluegrass	
SIHY		*Sitanion hystrix*	Bottlebrush squirreltail	dry
STOC		*Stipa occidentalis*	Western needlegrass	hot/dry

* Species used in the keys to associations and series

1 see Garrison and others (1976) for complete list of species codes

Chapter 3

Plant Association Descriptions

Ponderosa Pine Series

Douglas-fir Series

Grand Fir Series

Western Hemlock Series

Western Redcedar Series

Explanation of Data in the Plant Association Descriptions

The association descriptions are presented in order approximating a moisture gradient with the dry site ponderosa pine series first, followed by the Douglas-fir, grand fir, western hemlock, and western redcedar series, respectively. Each association description presents similar information.

Photographs

The photos are intended to give the reader a feel for the overall appearance of a representative stand. Variation in stand appearance is typical within an association. The pictures should be used as examples of the appearance of a site with that association, not as guides to what a site with that association should look like.

Environment and Distribution

The plot location maps include all plots, reconnaissance and intensive. The precipitation values are estimates for each plot derived from the Mt. Hood forest hydrologist's isohyetal map (see Figure 1). The other values are based on all study plots within the association.

Vegetation: Structure and Composition

The discussion and dominant vegetation table are based on all study plots within the association. The codes are from Garrison et al. (1976). Percent cover (%Cov) is the mean cover for that species calculated only for those plots within the association where the species was present (hence, zero values are excluded from the averaging). Constancy ("Cons") is the percent of the plots within the association where that species was present.

Timber Productivity and Management

These data (mean and standard error of the mean, s.e.) are based only on intensive plots. One exception is the use of reconnaissance plot data for the two ponderosa pine associations because we lack intensive plots there. Site index curves used are Curtis (1974) for Douglas-fir, Barrett (1978) for ponderosa pine, and Cochran (1979) for grand fir. The latter is a 50 year base curve whereas the former two curves are indexed to age 100. Growth basal area (Hall 1988) is an index of basal area growth and stockability. It is defined as that basal area at which dominant trees will grow one inch in diameter per decade at age 100. Ten year radial growth is the most recent decadal growth, in tenths of inches, of our site trees which are representative of the best growth on the plot. Yield capacity is an index of potential maximum productivity at culmination of mean annual increment. It is based on equations from the Region 6 stand exam handbook. SDI growth estimate is another estimate of maximum timber productivity at culmination which is based on site index and stocking, using the stand density index (SDI) of the plot. The trees per acre data are based on 5 variable radius plots per intensive plot and include all trees greater than 1 inch DBH. Reineke's stand density index of stocking is defined as the number of 10 inch DBH trees required to equal the given stand basal area (Reineke 1933). The bar graphs of live basal area use the tree codes from Garrison (1976) which are also listed in Table 8. The tree codes are listed in order approximating an elevation gradient. These values are based on the 5 variable radius plots on each intensive plot within the association.

Wildlife and Range

The snag data were tabulated from 3 variable radius basal area plots on each intensive plot within the association. Only snags greater than 10 inches DBH and greater than 10 feet tall were measured.

Fuels Management

The woody debris and fine fuels data are calculated using the line-intercept technique of Brown (1974). We used two parallel 100 foot long transects for coarse woody debris on each intensive plot and four short transects for the fine fuels: 10 feet long for 1-3 inch diameter pieces, 6 feet long for 1/4-1 inch diameter pieces, and 3 feet long for 1/4 inch diameter pieces. One ton per acre equals 2242 kilograms per hectare.

Soils

The soils information comes from a subset of both reconnaissance and intensive plots which includes most of the intensive plots. Effective soil depth is an index of the soil volume usable by roots. It is calculated by discounting the depth of the soil profile by the proportion occupied by coarse fragments (>2 mm).

Similar Associations

This section contrasts the similar associations in this guide and indicates the affinity to associations and habitat types in the literature.

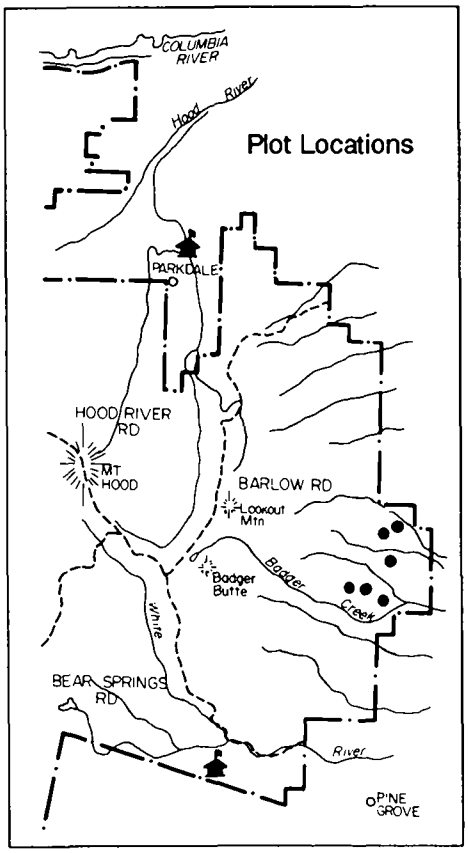
Ponderosa pine-Oregon White Oak/Arrowleaf Balsamroot
Pinus ponderosa-Quercus garryana/Balsamorhiza sagittata
PIPO-QUGA/BASA CPH2 11

Environment and Distribution

This association occupies hot, dry sites near the eastern edge of the Forest. These sites have very high temperatures during the growing season and low precipitation. This association is quite common on the lower elevation, south-facing portions of the major ridges of the Barlow Ranger District. It is usually found on ridges and upper slope positions with 20 to 30 per cent slopes.

	Range	Average
Elevation (ft):	2100-3300	2477
Precipitation (in/yr):	24-46	29
Slope (%):	5-35	22

Number of Plots:	6
Common Aspects:	South and east
Topographic Positions:	Ridgetops and mid slopes



Vegetation: Structure and Composition

This association includes ponderosa pine-Oregon white oak woodlands. Stands have about equal cover of ponderosa pine (PIPO) and Oregon white oak (QUGA). The pine is usually the taller species but rarely attains much commercial value or volume. The trees are generally short and sparse and may be of varied ages at a site. Except for occasional Douglas-fir (PSME), other tree species are absent from this association. Shrub cover is also sparse, generally confined to small amounts of squawcarpet (CEPR) or snowberry (SYMPH). The herb flora is very diverse. The diagnostic species is arrowleaf balsamroot (BASA). Tailcup lupine (LUCA) and nineleaf lomatium (LOTR) are almost always present and conspicuous. Idaho fescue (FEID) and bluebunch wheatgrass (AGSP) dominate the grass flora.

Dominant Vegetation

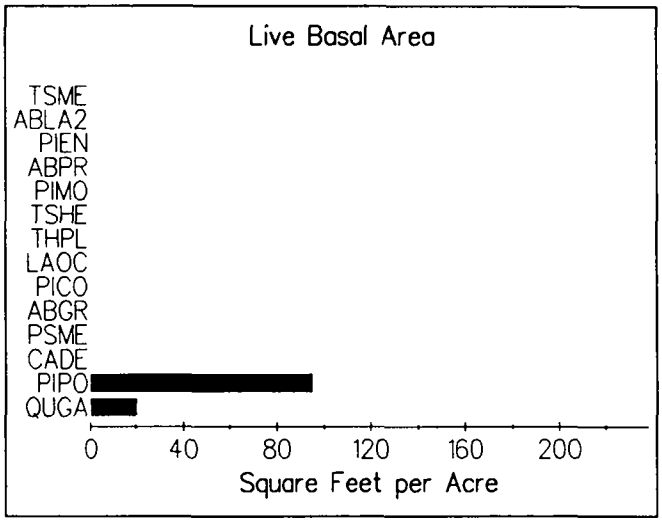
	Code	%Cov	Cons
Overstory Trees			
Ponderosa pine	PIPO	30	100
Oregon white oak	QUGA	12	83
Douglas-fir	PSME	9	33
Understory Trees			
Ponderosa pine	PIPO	4	66
Oregon white oak	QUGA	2	66
Douglas-fir	PSME	2	33
Shrubs			
Squawcarpet ceanothus	CEPR	1	50
Snowberry	SYMPH	1	50
Deerbrush ceanothus	CEIN	2	33
Forbs			
Tailcup lupine	LUCA	5	100
Western yarrow	ACMI	2	100
Arrowleaf balsamroot	BASA	3	83
Nineleaf lomatium	LOTR	2	83
Yellow hairy hawkweed	HIAL2	2	83
American vetch	VIAM	2	83
Grasses & Sedges			
Idaho fescue	FEID	10	50
Prairie Junegrass	KOCR	4	50
Bluebunch wheatgrass	AGSP	25	16
Elk sedge	CAGE	3	33

Timber Productivity and Management

Timber production is poor so other resources are of primary importance. Ponderosa pine grow to commercial size but growth rates and stocking are both low. Sites in this association are too dry for Douglas-fir. Select tree harvest and uneven-aged silvicultural systems are appropriate. The few large ponderosa pine and oaks are valuable roosting and nesting sites for turkeys and gray squirrels. These data are from reconnaissance plots; we did no intensive plots in this association.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	65	4.9	119	21.0	9.0	2.3

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
41	5.3	-	-	-	-	-	-



Wildlife and Range

This association is found in important winter and spring range. Production of browse and forage is not high, but the long snow-free season makes the available forage important for big game. Livestock use occurs, but this association provides only a small amount of forage for cattle. Good range conditions prevail. Some sites having this association are on historic major sheep driveways linking Mt. Hood with the eastern lowlands. These sites have more arrowleaf balsamroot, tailcup lupine (LUCA) and cheatgrass (BRTE) than other areas. The abundant oaks provide mast which is utilized by many wildlife species. This association provides quality habitat for the western gray squirrel *(Sciurus griseus)*. Merriam's wild turkey *(Meleagris gallopavo merriami)* may roost in the larger ponderosa pine in sites similar to this association (Lutz 1987). Underburning probably enhances forage and mast production, but this association is less responsive to treatment than other pine-oak communities.

Fuels Management

It is likely that sites in this association burned frequently during pre-settlement times. Prescribed underburning seems to be an effective method of enhancing forage production and maintaining the high diversity of plant species.

Soils

One soil sample in this association was surprisingly deep. This does not reflect the general pattern of shallow soils predominating on sites with this association. Further investigation of ponderosa pine-Oregon white oak zone soils may clarify this relationship. Forest floor organic matter accumulations are low because of both poor productivity of leaf litter and frequent fires.

Number of Soil Pits:	2
Effective Soil Depth (cm):	80
Soil Surface Texture:	Silt loam or loam
Parent Materials:	Conglomerate or ash

Similar Associations

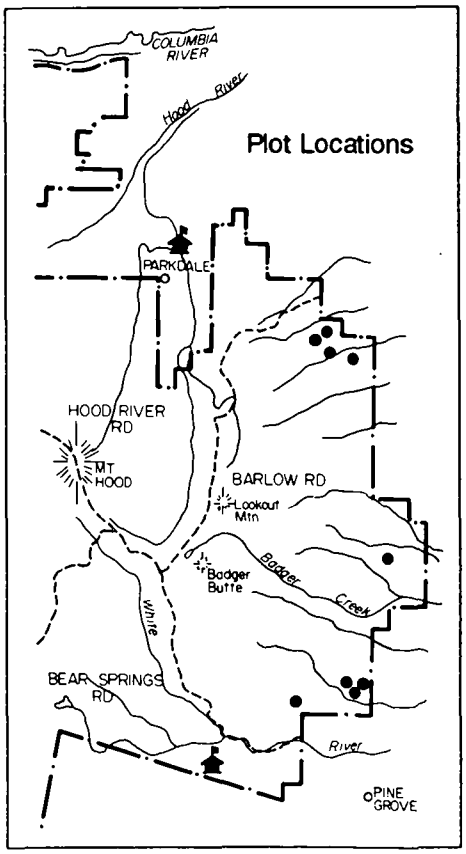
The sparse shrub cover separates this association from PIPO-QUGA/PUTR. This association is similar to the oak/ bitterbrush/ bluebunch wheatgrass community type described by Williams (1978) for the Badger Allotment, Barlow RD, but has less bitterbrush and more ponderosa pine. The PIPO/AGSP habitat in Montana (Pfister and others 1977) is slightly similar to this association.

Ponderosa pine-Oregon White Oak/Bitterbrush
Pinus ponderosa-Quercus garryana/Purshia tridentata
PIPO-QUGA/PUTR CPH2 12

Environment and Distribution

This is a widespread association of the ponderosa pine-Oregon white oak woodlands occurring at low elevations on the Barlow Ranger District on a variety of topographic positions. When found on slopes, southerly aspects are the rule, accentuating the droughty conditions which this association indicates. It is especially widespread south of Rock Creek Reservoir and in the Fivemile Creek area. In general, this association occurs in the driest areas of any forested community on the Mt. Hood National Forest. Precipitation averaged 25 inches/year for all plots taken in this association.

	Range	Average
Elevation (ft):	2050-2920	2485
Precipitation (in/yr):	20-30	25
Slope (%):	1-31	9
Number of Plots:	9	
Common Aspects:	Mostly south	
Topographic Positions:	Ridgetops and flats	



Vegetation: Structure and Composition

Sites having this association are sparsely stocked with trees. Ponderosa pine (PIPO) and Oregon white oak (QUGA) are almost equally abundant, though the oak often takes the form of a shrub. The ponderosa pine may be of varied ages, including seedlings to as old as 160 years. Most sites lack ponderosa pine older than 70 years (at breast height) because these sites burned very frequently, and perhaps intensely, before the advent of fire suppression in the early 1900's. Douglas-fir (PSME) is often present, but in small amounts and with poor growth characteristic of a marginal population. Other tree species are absent. Shrub cover may be substantial. Bitterbrush (PUTR) is characteristic and in the absence of fire will constitute much of the shrub layer. Herb and grass cover is substantial and diverse. This is the most grass-rich association of the dry forests on the Mt. Hood NF. Common herb species characteristic of dry sites include: tailcup lupine (LUCA), nineleaf lomatium (LOTR), smooth prairiestar (LIGL) and yellow hairy hawkweed (HIAL2).

Dominant Vegetation

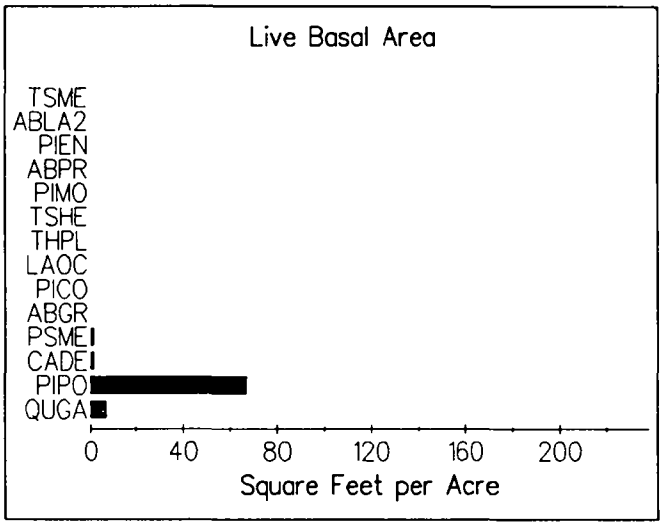
	Code	%Cov	Cons
Overstory Trees			
Ponderosa pine	PIPO	19	100
Oregon white oak	QUGA	8	88
Douglas-fir	PSME	6	44
Understory Trees			
Oregon white oak	QUGA	6	100
Ponderosa pine	PIPO	8	55
Douglas-fir	PSME	2	44
Shrubs			
Bitterbrush	PUTR	9	100
Snowberry	SYMPH	2	44
Serviceberry	AMAL	1	33
Greenleaf manzanita	ARPA	10	11
Forbs			
Western yarrow	ACMI	3	100
Yellow hairy hawkweed	HIAL2	1	100
Smooth prairiestar	LIGL	3	77
American vetch	VIAM	3	77
Tailcup lupine	LUCA	3	55
Grasses & Sedges			
Prairie Junegrass	KOCR	3	77
Idaho fescue	FEID	3	55
California brome	BRCA	7	44
Bluebunch wheatgrass	AGSP	1	33

Timber Productivity and Management

Timber is a minor resource in this association. Basal area and site index values are the lowest of any eastside forested association. Stand management may help meet wildlife objectives (by enhancing browse and forage production) but adequate reforestation will be extremely difficult to achieve, especially in clearcuts. Select tree harvests and uneven-aged silvicultural systems are appropriate. Some large ponderosa pine and oaks should be maintained for wildlife use. These data are from reconnaissance plots; we did no intensive plots in this association.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	63	2.4	124	22.0	16.0	2.4

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
38	2.5	-	-	-	-	-	-



Wildlife and Range

This association provides many vital wildlife features. The snow-free season is relatively long, making these sites valuable as winter range. The abundant and high quality browse, including bitterbrush and deerbrush, help support substantial deer and elk populations. Much of this association is grazed by cattle. Some areas probably were over-grazed by sheep during the 1920's, and still have conspicuous amounts of cheatgrass (BRTE). The abundant oaks provide browse as young plants and shoots, acorns as mature trees, and even in death provide high quality nesting hollows and cavities. Sites in this association are vital habitat for western gray squirrels and provide important roosting for wild turkeys.

Fuels Management

The wildlife habitat within this association can often be enhanced by underburning. Prescribed underburning emulates the naturally short fire-return cycle prevalent during pre-settlement times. Burning stimulates young shoot growth for browse production, prevents impenetrable brush thickets from developing, and maintains a wide spacing of trees. Relatively frequent and cool burns do not destroy the larger trees or snags important to wildlife. Hot burns may eliminate bitterbrush.

Soils

Soils are fairly typical for the eastern portion of the Mt. Hood National Forest. Silty loam textured surface layers form from volcanic ash and loess. Forest floor organic layers are also very thin because of low leaf litter production and frequent fires.

Number of Soil Pits:	1
Effective Soil Depth (cm):	47
Soil Surface Texture:	Silt loam
Parent Materials:	Breccia or ash

Similar Associations

The abundance of bitterbrush (PUTR) and a variety of other shrubs separates this association from PIPO-QUGA/BASA. This association includes most of the sites in the Badger Allotment, Barlow RD, described by Williams (1978) as the PIPO-QUGA/PUTR/FEID, PIPO/PUTR/LULE and PIPO/PUTR/LUCA community types. The PIPO/PUTR habitat type in Montana (Pfister and others 1977) is analogous but not very similar to this association.

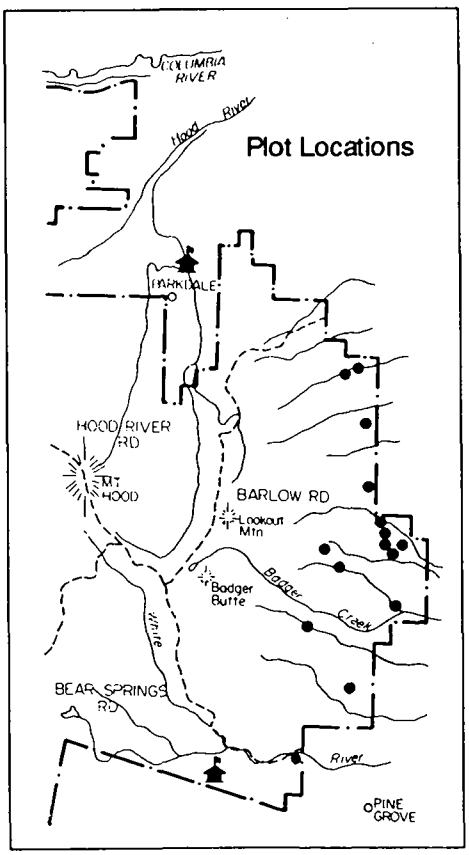
Douglas-fir/Elk Sedge
Pseudotsuga menziesii/Carex geyeri
PSME/CAGE CDG1 41

Environment and Distribution

This association is widespread throughout the lower elevations of the Barlow Ranger District. PSME/CAGE stands form a band between the lower elevation, hot, dry ponderosa pine-Oregon white oak associations and the more moist grand fir zone at higher elevations. Slopes are often quite steep, averaging 33% on our plots. Most aspects are represented, but north is uncommon. Precipitation for the plots is very low, averaging 27 inches per year.

	Range	Average
Elevation (ft):	2100-3200	2600
Precipitation (in/yr):	23-34	27
Slope (%):	7-78	33

Number of Plots:	15 (intensive = 5)
Common Aspects:	Variable
Topographic Positions:	Upper slopes



Vegetation: Structure and Composition

Forests in this association are dominated by ponderosa pine (PIPO) and Douglas-fir (PSME). Stands are generally well stocked with a continuous canopy of conifers. Exclusion of fire has increased the dominance of Douglas-fir. Oregon white oak (QUGA) is an important seral species but eventually is excluded by the dense stands of Douglas-fir developing in the absence of fire. Douglas-fir is the most common seedling species. Grand fir (ABGR) is usually present in only small amounts and grows poorly as regeneration. The understory is usually sparse except for dense swards of elk sedge (CAGE), which is always the dominant understory species in the absence of excessive livestock use or dense canopy coverage. Many dry-site herb species, such as yellow hairy hawkweed (HIAL2), smooth prairiestar (LIGL), woods strawberry (FRVE), and thickleaf peavine (LALA2), are common in smaller amounts. Idaho or western fescue (FEID, FEOC) are occasionally abundant and contribute valuable forage. Shrub cover is slight.

Dominant Vegetation

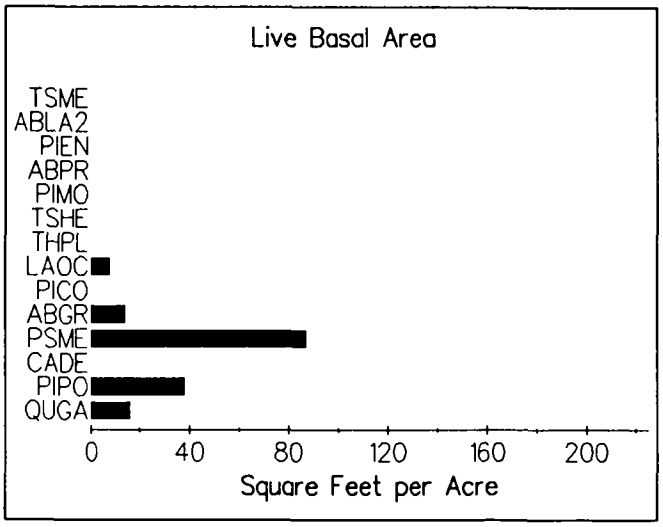
	Code	%Cov	Cons
Overstory Trees			
Ponderosa pine	PIPO	11	93
Douglas-fir	PSME	42	86
Oregon white oak	QUGA	10	66
Grand fir	ABGR	2	40
Understory Trees			
Douglas-fir	PSME	3	73
Grand fir	ABGR	2	40
Oregon white oak	QUGA	2	26
Ponderosa pine	PIPO	1	13
Shrubs			
Snowberry	SYMPH	3	80
Creeping hollygrape	BERE	2	53
Serviceberry	AMAL	2	46
Forbs			
Sweet-cicely	OSMOR	2	66
Woods strawberry	FRVE	1	66
Yellow hairy hawkweed	HIAL2	1	66
Smooth prairiestar	LIGL	2	60
Tailcup lupine	LUCA	6	46
Grasses & Sedges			
Elk Sedge	CAGE	25	100
Idaho fescue	FEID	10	46
Western fescue	FEOC	17	26

Timber Productivity and Management

The hot and dry character of sites with this association dictates the use of cautious management. Timber productivity is lower than most areas on the Forest, though stands generally have commercial value. Clearcutting often leads to drought-induced regeneration failure, but may be the only logical harvest method in areas of concentrated root rot. In such cases use of small clearcuts having shade-providing tree borders is recommended. Shelterwood and partial cuts are generally less risky. Ponderosa pine is the best choice for plantation establishment. Stocking control is desirable because these stands can not sustain much tree growth at high densities, and because they provide transitory range for wildlife and livestock.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	74	6.8	196	44.4	10.6	1.9
PSME	100	82	4.8	160	21.4	9.4	2.2

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
55	6.4	37	7.5	337	201	247	43.9



Wildlife and Range

Big game and livestock utilize the elk sedge and grasses occurring on sites in this association. Though forage productivity is not high, this association covers sufficient acreage to be important as early summer range. Because this association includes some of the lowest elevation dense timber stands, it can provide vital thermal cover for deer and elk in winter. Native grass species (Idaho and western fescue) and elk sedge will normally revegetate most sites following disturbance. Severe soil disturbance may require seeding cereal rye to prevent erosion. Orchardgrass, wheatgrasses or hard fescue can easily outcompete planted conifers, so they are not appropriate for seeding forest regeneration units. The larger trees found in this association are very important as roosting and nesting sites for turkeys, gray squirrels and other wildlife. Thinned stands of pole-sized Douglas-fir having considerable amounts of down woody debris are critical for Merriam's wild turkey nesting.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
18	0	2	6	10

Fuels Management

Conservation of organic matter, both in the form of coarse woody debris and as duff, is especially important to the long-term productivity of sites as dry as those in this association. Machine piling and duff displacement can reduce site productive potential. Wildlife needs for snags and down wood are important here so cool prescribed burning is essential. Elk sedge sprouts back readily following broadcast burns.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
593	6.20	308	3.2	3.4

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.41	1.10	1.36

Soils

This association has soils of typical fertility for the Mt. Hood National Forest eastside. The fine sandy loam textures result from aerial deposition of fine ash and loess. Relatively small amounts of rocks in the soil matrix leads to the moderate effective soil depth of 45 cm. These soils compact readily.

Number of Soil Pits:	4
Effective Soil Depth (cm):	45
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on conglomerate, or ash on basalt

Similar Associations

This association occurs on hotter, harsher sites than Douglas-fir/western fescue (PSME/FEOC) and has much less shrub cover than Douglas-fir/oceanspray/elk sedge (PSME/HODI/CAGE). PSME/CAGE occupies the lower elevation, hot and dry fraction of the ABGR/CAGE association described by Williams (1978) for the Badger Allotment, Barlow Ranger District. PSME/CAGE is considerably hotter and drier, with greater management problems, than the average site included in the Badger version of ABGR/CAGE. The Mixed conifer/snowberry/elk sedge association described on the Warm Springs Indian Reservation (Marsh 1985) is much like PSME/CAGE. This association is quite similar to PIPO-PSME/CAGE of the Blue Mountains (Hall 1973), and somewhat similar to the PSME/CAGE habitat types described in Idaho (Steele and others 1981, Cooper and others 1987) and Montana (Pfister and others 1977).

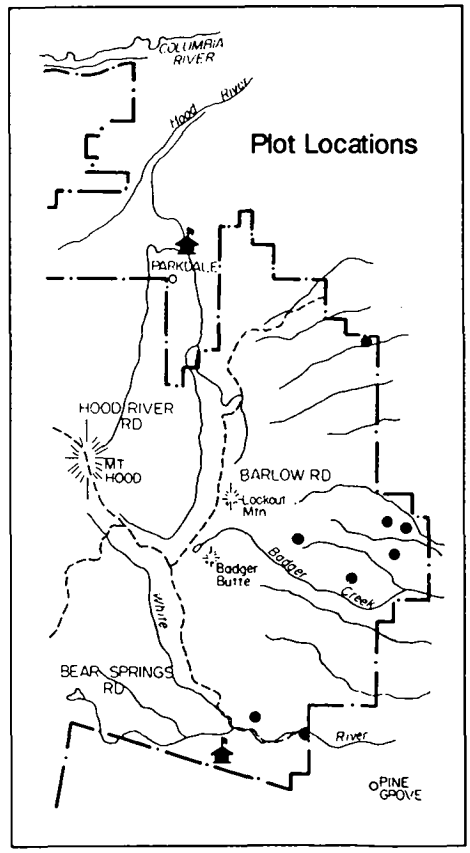
Douglas-fir/Western Fescue
Pseudotsuga menziesii/Festuca occidentalis
PSME/FEOC CDG3 21

Environment and Distribution

This association represents the most mesic environments of the Douglas-fir series, but can never-theless be characterized as relatively hot and dry. It occurs throughout the Barlow Ranger District between the drier ponderosa pine-Oregon white oak associations and the more moist grand fir zone at higher elevations. North facing and otherwise shaded slopes are most common.

	Range	Average
Elevation (ft):	2330-3160	2709
Precipitation (in/yr):	24-57	33
Slope (%):	5-45	21

Number of Plots:	8 (intensive = 4)
Common Aspects:	Mostly north
Topographic Positions:	Lower slopes; flats



Vegetation: Structure and Composition

This association includes grass-rich stands of ponderosa pine (PIPO) and Douglas-fir (PSME). When undisturbed, they are well-stocked and yet may have substantial understory cover of grasses, herbs and shrubs. Douglas-fir regeneration is common and occasional ponderosa pine regenerate in mixed age stands. Old-growth ponderosa pine dominate many stands in this association. Grand fir occurs sporadically but never occupies much of the canopy and grows poorly. Oregon white oak (QUGA) is nearly always present, but as a minor species. It plays a seral role, being excluded by conifers as the canopy closes. Much of the area having this association probably was occupied by open ponderosa pine forests which became dominated by Douglas-fir following fire suppression activities early in this century. Western fescue (FEOC) is found in dense patches along with scattered oniongrass (MEBU). Elk sedge is usually present but in small amounts. Many dry-site forb species are common, including miner's lettuce (MOPE), woods strawberry (FRVE), smooth prairiestar (LIGL), and bigleaf sandwort (ARMA3). Shrubs are generally present but not abundant.

Dominant Vegetation

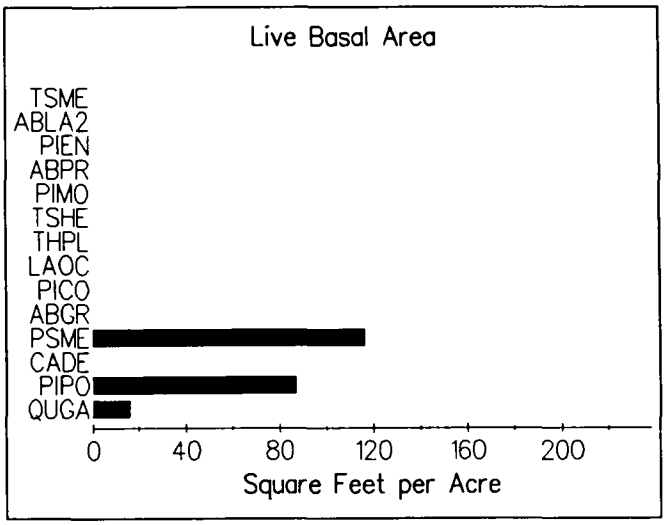
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	38	100
Ponderosa pine	PIPO	13	100
Oregon white oak	QUGA	3	75
Understory Trees			
Douglas-fir	PSME	4	87
Oregon white oak	QUGA	1	62
Grand fir	ABGR	1	37
Ponderosa pine	PIPO	3	25
Shrubs			
Snowberry	SYMPH	3	100
Serviceberry	AMAL	4	75
Tall oregongrape	BEAQ	4	50
Forbs			
Woods strawberry	FRVE	1	75
Sweet-cicely	OSMOR	1	75
Miners lettuce	MOPE	1	62
Grasses & Sedges			
Elk Sedge	CAGE	3	75
Western fescue	FEOC	16	62
Oniongrass	MEBU	2	37

Timber Productivity and Management

Timber productivity is moderate. Once established, Douglas-fir grow well, but because of the dryness of these sites, ponderosa pine is the species of choice for planting. Clearcuts are difficult to regenerate unless they are kept small and designed to maximize shade. Douglas-fir should be capable of regenerating shelterwoods either naturally or with planting. Stocking control is important because dense stands will have stagnated growth. Basal areas above 250 ft^2/acre likely result in considerably reduced individual tree growth.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	81	8.6	175	42.2	8.2	1.8
PSME	100	100	6.2	235	52.3	14.2	3.2

Yield Capacity ft^3/ac/yr		SDI Growth Estimate ft^3/ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
79	8.9	90	18.0	876	431	416	57.1



Wildlife and Range

Stands in this association include some of the best forested rangeland on the Mount Hood National Forest. Production of western fescue is fairly high and is utilized by cattle and elk. The typical north-facing stands also provide critical thermal protection for elk during winter. The larger ponderosa pine provide essential roosting and nesting habitat for many species, including Merriam's wild turkey and the western gray squirrel. Thinned stands of pole-sized Douglas-fir may be the best nesting habitat for Merriam's wild turkeys. Large ponderosa pine snags are quite abundant on the plots in this association.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
14	8	0	6	0

Fuels Management

The dense stands of pole and whip-sized Douglas-fir common in stands of this association require treatment following harvest activities. Machine piling slash can damage potential site productivity by compacting soil, eliminating coarse woody debris, and displacing the duff layer.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total # /acre	20"+ Dia. # /acre	12-19" Dia. # /acre
435	5.00	145	2.7	0.0

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.42	1.48	1.70

Soils

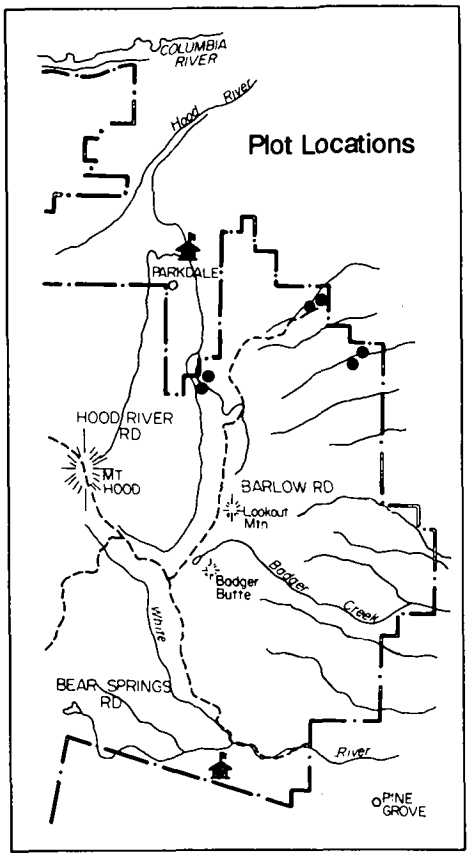
Typical eastern Mt. Hood National Forest ash-laden soils prevail at sites in this association. Sites are more mesic than the rest of the Douglas-fir series because north aspects prevail, not because of soil moisture-holding properties. These ashy soils are easily compacted by heavy machinery. The prevalence of low nutrient levels suggests that duff displacement or removal by burning will adversely impact long-term site productivity.

Number of Soil Pits:	4
Effective Soil Depth (cm):	56
Soil Surface Texture:	Silt loam and fine sandy loam
Parent Materials:	Ash on varried rock types

Similar Associations

This association is quite similar to PSME/CAGE and PSME/HODI/CAGE, but has more western fescue and very little elk sedge. Stands in this association comprise a subset of those included in the ABGR/CAGE association described for the Badger Allotment (Williams 1978). PSME/FEOC lacks a grand fir component but is otherwise quite similar to the Mixed conifer/Snowberry/Elk sedge type described for the Warm Springs Indian Reservation (Marsh 1985).

Douglas-fir/Oceanspray/Elk Sedge
Pseudotsuga menziesii/Holodiscus discolor/Carex geyeri
PSME/HODI/CAGE CDS2 31



Environment and Distribution

This association indicates hot and dry sites. Sites either have very low precipitation levels (on the east edge of the Forest) or are on steep, rocky, exposed slopes which are effectively dry for plants. This association is common on the north end of Barlow Ranger District and the northeastern portion of the Hood River RD. Elevations are typically about 3000 feet with steep slopes being most common. Most plots have southerly aspects except for the lowest elevation sample where a similarly dry site occurs on a north aspect.

	Range	Average
Elevation (ft):	2740-3600	3130
Precipitation (in/yr):	27-87	49
Slope (%):	20-65	36

Number of Plots:	6 (intensive = 4)
Common Aspects:	Mostly south
Topographic Positions:	Upper slopes

Vegetation: Structure and Composition

This association is characterized by brushy stands of ponderosa pine (PIPO) and Douglas-fir (PSME). The only other tree species present are small amounts of Oregon white oak (QUGA) and grand fir (ABGR) of poor vigor. Ponderosa pines over 200 years old are common. The Douglas-fir is generally younger, usually less than 80 years. They became established after fire suppression halted the frequent wildfires prevalent in the area until the early 1900's. Prior to that, ponderosa pine dominated these sites. Now Douglas-fir prevails as the regeneration layer. The relatively continuous tree canopy is occasionally broken by patches of oceanspray (HODI), serviceberry (AMAL), and snowberry (SYAL or SYMO). Other dry-site shrubs are common, including California hazel (COCO2), tall Oregongrape (BEAQ), and sometimes small amounts of creeping hollygrape (BERE). Elk sedge is the dominant herb; it may form dense swards or merely cover small areas. The rest of the herb flora is quite diverse including many species typical of dry Cascadian forests: bigleaf sandwort (ARMA3), western fescue (FEOC), white hawkweed (HIAL), Nuttall's peavine (LANE), starflower (TRLA2), sweet cicely (OSCH) and woods strawberry (FRVE). Some herb species of drier sites occasionally occur in small amounts: balsamroot arrowleaf (BASA), California brome (BRCA) and pinegrass (CARU).

Dominant Vegetation

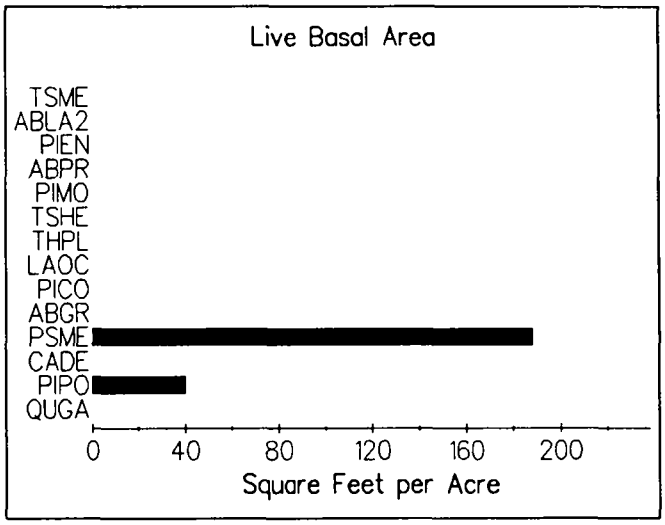
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	33	100
Ponderosa pine	PIPO	18	100
Oregon white oak	QUGA	6	33
Grand fir	ABGR	2	33
Understory Trees			
Douglas-fir	PSME	6	66
Oregon white oak	QUGA	2	66
Grand fir	ABGR	1	33
Ponderosa pine	PIPO	2	33
Shrubs			
Oceanspray	HODI	3	100
Serviceberry	AMAL	2	100
Snowberry	SYMPH	14	83
California hazel	COCO2	2	83
Tall Oregongrape	BEAQ	1	66
Forbs			
Star-flower	TRLA2	2	100
Bigleaf sandwort	ARMA3	6	83
Sweet-cicely	OSMOR	1	83
Nuttall's peavine	LANE	4	66
Grasses & Sedges			
Elk Sedge	CAGE	20	100
Western fescue	FEOC	2	66
Pinegrass	CARU	4	33

Timber Productivity and Management

Timber productivity is moderate. Stand establishment following clearcutting can be very difficult because of drought and plantability. Harvest by either shelterwood or the select tree method followed by planting ponderosa pine is more likely to succeed than clearcutting. Growth basal area values of 245 for Douglas-fir and 178 for ponderosa pine indicate that sites in this association can sustain individual tree growth at stocking levels up to 250 ft^2/acre.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	89	5.2	178	39.9	7.6	0.8
PSME	100	119	2.6	245	21.1	15.7	1.8

Yield Capacity ft^3/ac/yr		SDI Growth Estimate ft^3/ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
107	3.8	117	26.0	579	379	412	95.3



Wildlife and Range

Vegetation found in this association is highly palatable for deer and elk. The elk sedge may be grazed, and species such as serviceberry, oceanspray and California hazel are browsed by deer. Fairly dense timber stands offer thermal protection during winter, so these sites receive year-around wildlife use. Intensive plots in this association lacked snags.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
0	0	0	0	0

Fuels Management

The abundant browse and the shallow soil may be damaged by burning. The use of heavy machinery to pile slash can easily lead to soil compaction. Because of the difficulty of seedling establishment at sites in this association, fuels treatments which allow advance regeneration to survive are particularly important.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
310	3.50	177	0.0	1.5

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.71	1.54	1.79

Soils

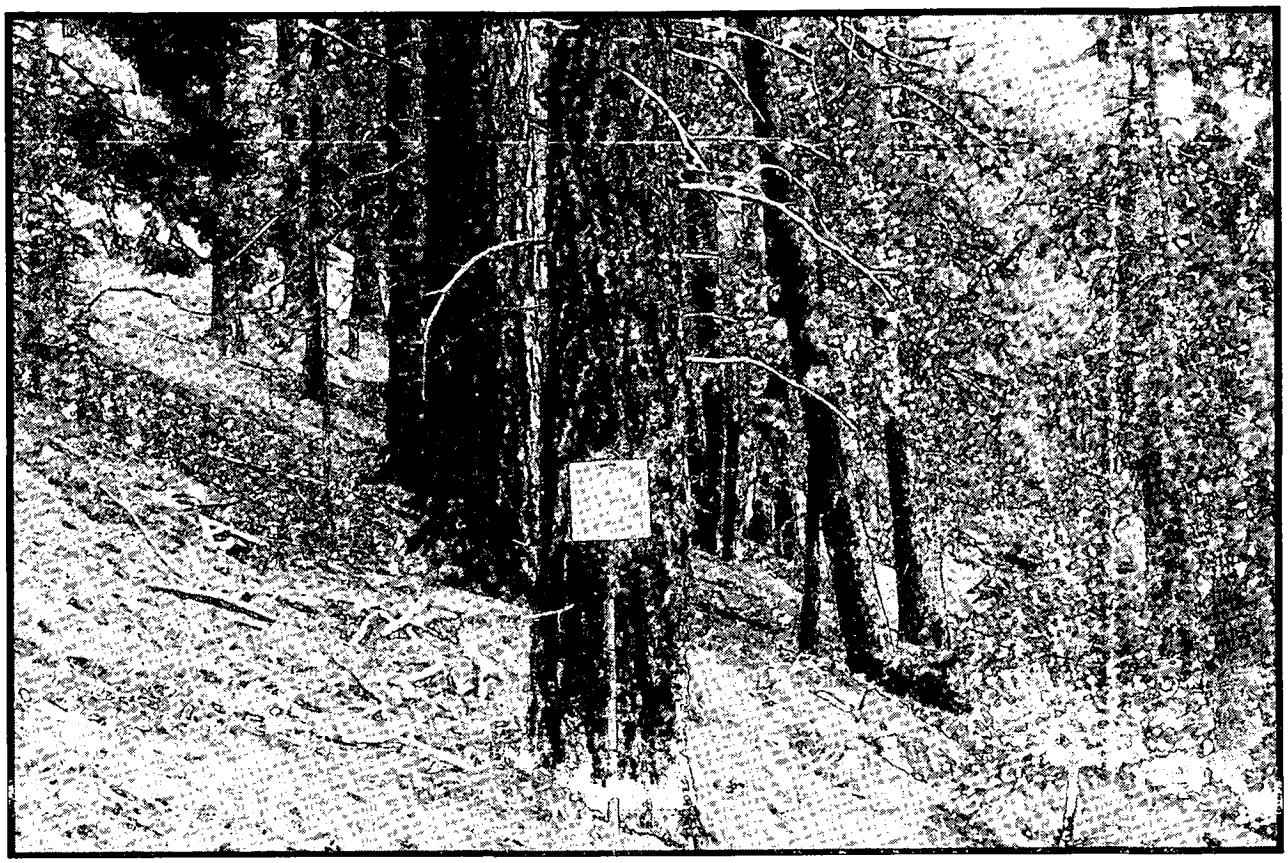
Typical Mt. Hood eastern Cascade fine sandy loam textured, ash-laden soils prevail on sites in this association. Though stony conditions do exist, the association average effective soil depth of 49 cm is adequate to hold and supply water for plant growth. Long-term site productivity is enhanced by the presence of large woody debris. Down wood holds soil in place, is the substrate for nitrogen-fixing bacteria, and if incorporated into the soil to rot, may serve as soil moisture reservoirs for tree roots and mycorrhizae.

Number of Soil Pits:	5
Effective Soil Depth (cm):	49
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt, or basalt

Similar Associations

This association is similar to PSME/CAGE except the latter is less shrubby and not restricted to the north end of Barlow Ranger District. The PIPO-PSME/SYAL-HODI association of the Blue Mountains (Hall 1973) is somewhat similar to this association.

Douglas-fir/Pinemat Manzanita
Pseudotsuga menziesii/Arctostaphylos nevadensis
PSME/ARNE CDS6 62

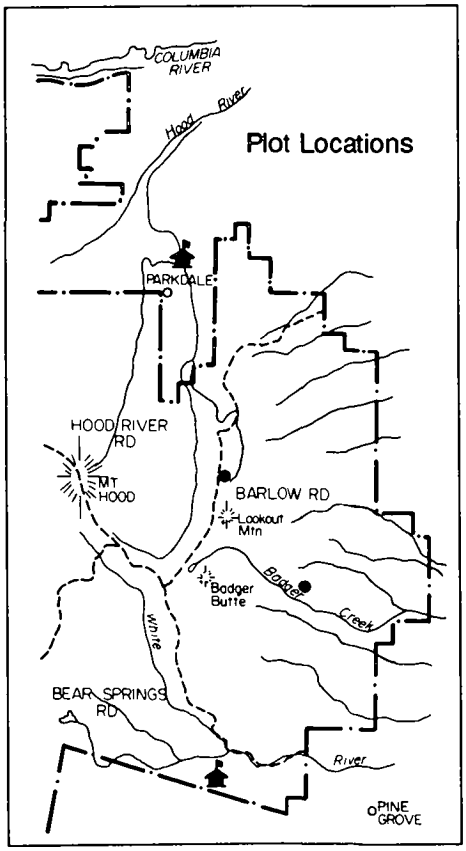


Environment and Distribution

Steep, rocky slopes near ridgetops which receive intense solar radiation are typical sites for this association. Sample plots are above 4000 feet in elevation on both Barlow and Hood River Ranger Districts. This association occupies small areas which are surrounded by more dense forest stands and unforested ridgetops. The rocky, shallow soils have so little moisture-holding capacity that these sites are effectively very dry for plant growth despite the substantial input of precipitation. These sites are exposed to high winds. Wind detracts from site moisture status by blowing off snow, directly desiccating plants, and eroding soil.

	Range	Average
Elevation (ft):	4200-4600	4400
Precipitation (in/yr):	58-90	74
Slope (%):	50	50

Number of Plots:	2 (intensive = 2)
Common Aspects:	Variable
Topographic Positions:	Upper slopes



Vegetation: Structure and Composition

This association includes sparse, mixed age stands of ponderosa pine (PIPO) and Douglas-fir (PSME), with trace amounts of grand fir (ABGR). These sites are too hot and exposed for grand fir to thrive. The ponderosa pine are generally older than the Douglas-fir. It appears that the Douglas-fir are slowly invading these sites now that wildfires are suppressed. Shrub growth is patchy, dominated by pinemat manzanita. Other hot-site species present include greenleaf manzanita (ARPA), pinegrass (CARU), and western needlegrass (STOC). Penstemons provide colorful floral displays. Sites having this association are characterized by a large amount of open, rocky gound.

Dominant Vegetation

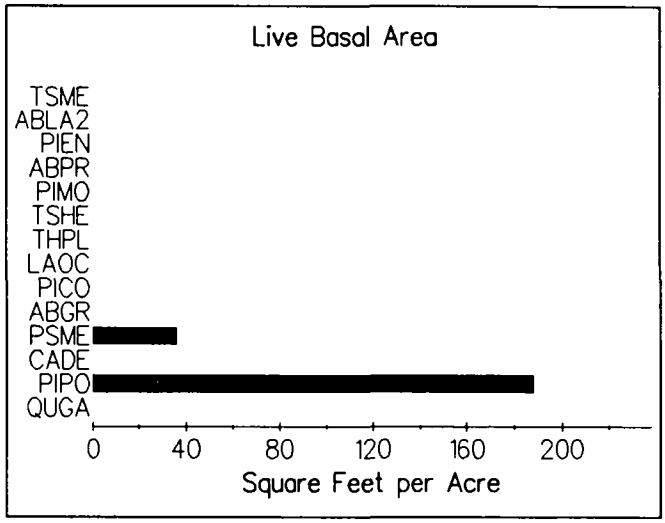
	Code	%Cov	Cons
Overstory Trees			
Ponderosa pine	PIPO	34	100
Douglas-fir	PSME	4	100
Grand fir	ABGR	2	50
Understory Trees			
Douglas-fir	PSME	6	100
Grand fir	ABGR	3	100
Ponderosa pine	PIPO	2	100
Shrubs			
Pinemat manzanita	ARNE	38	100
Golden chinkapin	CACH	2	100
Greenleaf manzanita	ARPA	1	100
White spirea	SPBE	2	50
Forbs			
Penstemon	PENST	1	100
Western yarrow	ACMI	1	100
Bracken fern	PTAQ	2	50
Grasses & Sedges			
Western fescue	FEOC	3	50
Pinegrass	CARU	2	50
Elk Sedge	CAGE	1	50

Timber Productivity and Management

Timber productivity is fairly low. Site index values for Douglas-fir are the lowest of any association described in this guide. The trees which do occur tend to be in patches where they have been able to find sufficient soil or cracks in the rocks. Timber harvest may require selective logging because these sites are very difficult to regenerate.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	78	0.6	211	38.0	9.0	1.8
PSME	100	80	0.6	405	85.5	20.2	4.2

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
63	1.5	64	11.7	180	2.5	378	60.3



Wildlife and Range

Wildlife use is not major in sites of this association. Big-game browse is neither plentiful nor of high quality. Plots had few snags. This association is non-range for domestic ungulates.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
2	2	0	0	0

Fuels Management

Fuel loadings are light. Because few opportunities for clearcut harvests are likely, prescribed burnings are generally not required.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
108	1.00	19	0.0	3.5

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.16	1.44	0.94

Soils

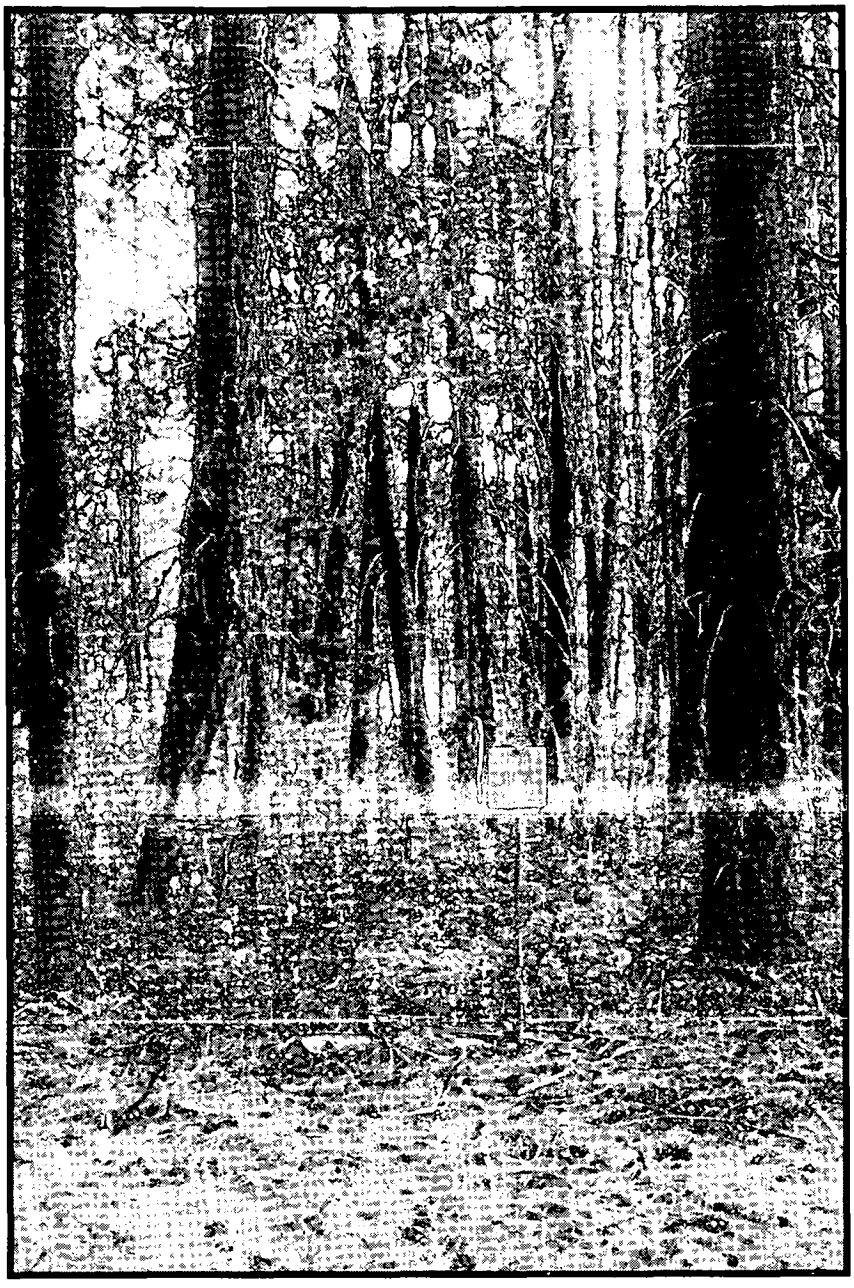
Very shallow soils are characteristic for stands of this association. Total soil depth and rooting depth (62 cm) and effective soil depth (13 cm) are the shallowest of any association described in this guide. The percent of the surface covered with rock is also highest. Plantability is poor.

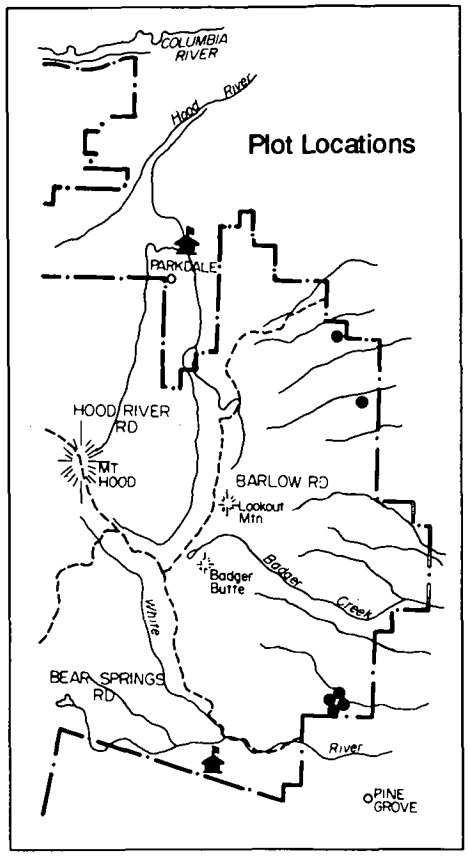
Number of Soil Pits:	1
Effective Soil Depth (cm):	13
Soil Surface Texture:	Silt loam
Parent Materials:	Breccia or basalt

Similar Associations

This association occurs at higher elevations and is more closely associated with rocky sites than other Mt. Hood National Forest Douglas-fir series associations. It is only slightly similar to the Mixed conifer/Manzanita association described by Volland (1985) for the Central Oregon Pumice zone. PSME/ARNE is restricted to rocky spots, has a less diverse flora, has much more Douglas-fir, and lacks the Shasta red fir found in the type described by Volland. The PSME/ARUV types of the Okanogon National Forest (Williams and Lillybridge 1983) and Montana (Pfister and others 1977) are analogous but only slightly similar to this association.

Douglas-fir/Common Snowberry
Pseudotsuga menziesii/Symphoricarpos albus
PSME/SYAL CDS6 61





Environment and Distribution

This association indicates hot and dry environments. It is found only on the Barlow Ranger District, between the more moist grand fir zone at higher elevations and the drier ponderosa pine-Oregon white oak associations below. Plots are primarily on flats and gentle slopes with northeastern to eastern aspects. Precipitation is always low, averaging only 28 inches per year. Though covering a small area, this association is important because these dry sites are difficult to regenerate.

	Range	Average
Elevation (ft):	2370-3050	2640
Precipitation (in/yr):	27-30	28
Slope (%):	2-36	10

Number of Plots:	6 (intensive = 2)
Common Aspects:	North and east
Topographic Positions:	Flats

Vegetation: Structure and Composition

Fairly dense stands of Douglas-fir (PSME), with scattered ponderosa pine (PIPO), characterize this association. Mature ponderosa pine are always present but do not typically regenerate in stands. Sampled stands were generally less than 80 years old, although individual trees up to 150 years old were found. Grand fir (ABGR) is often present in small amounts and with poor vigor; sites in this association are at the margins of its environmental tolerance. The only other tree species present is Oregon white oak (QUGA), which occurs as an early seral pioneer, gradually dying off as a canopy of Douglas-fir develops. Understory plant cover is sparse. Common snowberry (SYAL) is the only shrub species to achieve prominence. The frequent appearance of creeping hollygrape (BERE) indicates the hot and dry nature of this association. Common herb species include Idaho and western fescue (FEID and FEOC), sweet cicely (OSCH), yellow hairy hawkweed (HIAL2) and lambstongue groundsel (*Senecio integerrimus* var. *ochroleucus*).

Dominant Vegetation

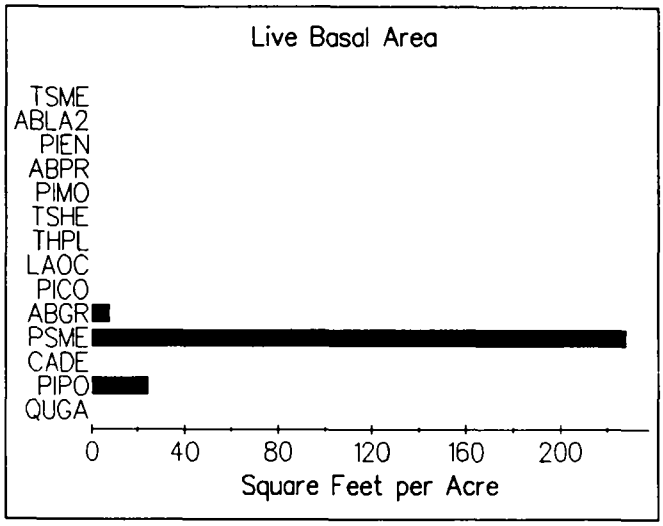
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	55	100
Ponderosa pine	PIPO	8	100
Oregon white oak	QUGA	4	66
Grand fir	ABGR	3	33
Understory Trees			
Douglas-fir	PSME	3	83
Grand fir	ABGR	2	66
Shrubs			
Common Snowberry	SYAL	4	100
Creeping hollygrape	BERE	2	50
Forbs			
Sweet-cicely	OSMOR	3	100
Yellow hairy hawkweed	HIAL2	2	83
Woods strawberry	FRVE	2	83
Lambstongue (Senecio)	SEINO	1	66
Western yarrow	ACMI	1	66
Nuttall's peavine	LANE	3	50
Grasses & Sedges			
Western fescue	FEOC	1	50
Idaho fescue	FEID	1	50

Timber Productivity and Management

Timber productivity is the highest of the eastside Douglas-fir series associations. Forests in this association have good stocking and height growth; Douglas-fir site index averaged 125 on the intensive plots. This association can be managed for either ponderosa pine or a mixture of ponderosa pine and Douglas-fir. Clearcuts should include some provision to shade seedlings to ensure prompt regeneration. Shelterwood or group tree cutting are are also appropriate silvicultural systems. The droughty conditions indicate that treatments adversely affecting soil moisture status, such as competing grasses, compaction, duff elimination, etc., need to be carefully managed if timber regeneration is desired.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	87	1.9	363	99.2	14.3	3.0
PSME	100	125	6.7	278	35.0	15.6	4.8

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
110	15.7	134	47.6	376	194	440	97.6



Wildlife and Range

Ungulates (wild and domestic) do utilize sites in this association, but browse and forage is sparse and seeding will provide only small additional gains. These sites do have considerable value as transitory range, yet grass seeding needs to be carefully coordinated with silvicultural activities if timber production is a goal. Seeded cereal rye in regeneration units provides forage yet it is not is so persistent as rhizomatous grasses (eg. hard fescue) or orchardgrass. Large ponderosa pine provide important roosting habitat and thinned stands of pole-sized Douglas-fir, with untreated slash, are the most frequent nesting sites for Merriam's wild turkey.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
0	0	0	0	0

Fuels Management

Because sites in this association are so dry, treatments which remove duff and large logs should be avoided. Large woody debris provides shaded microsites for seedlings, is the substrate for nitrogen-fixing bacteria, and if incorporated into the soil to rot, makes an excellent moisture-holding substrate for tree rooting and mycorrhizae. Most sites in this association are flat enough to allow unrestricted tractor use, yet machine piling of slash can easily lead to compacted soils having insufficient water infiltration capacity to support tree growth.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
299	3.00	384	0.0	0.0

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.60	2.28	0.94

Soils

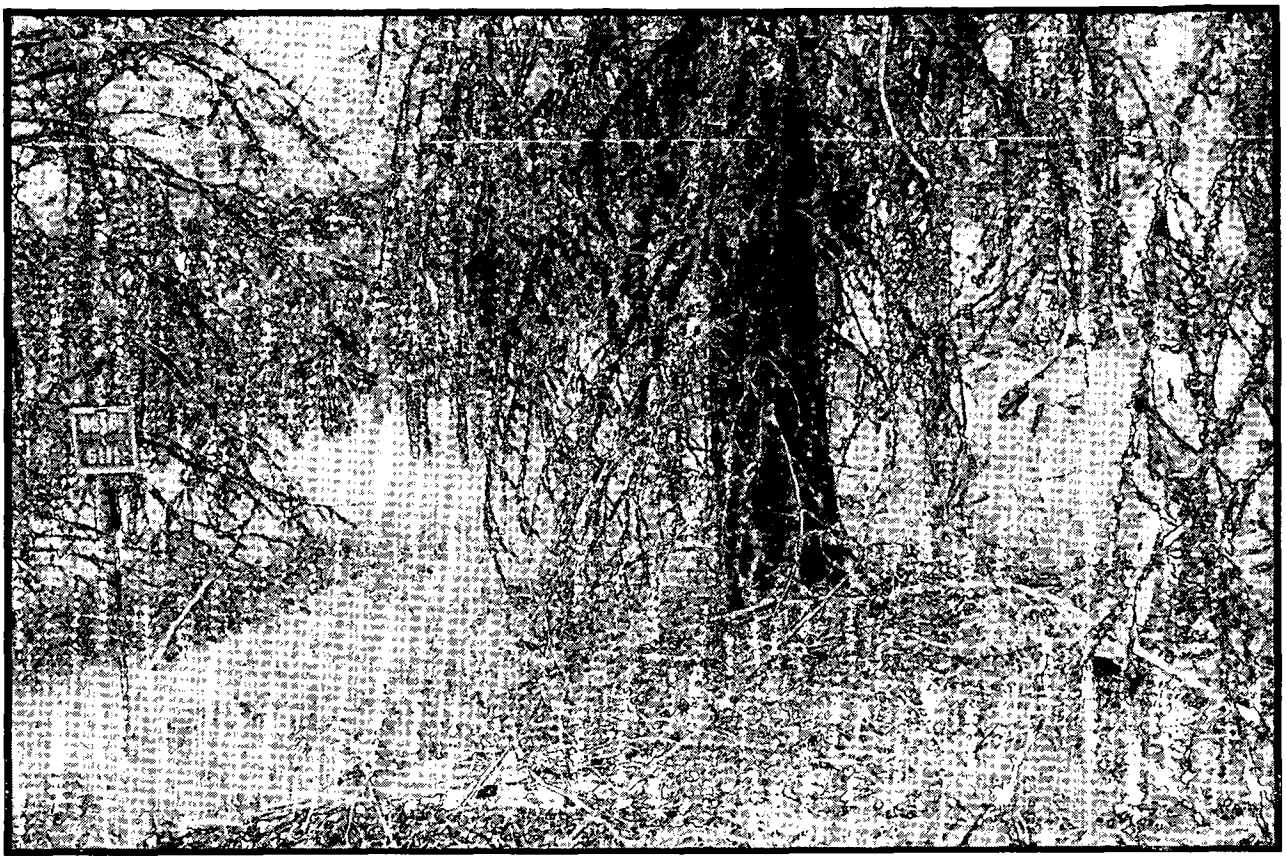
Soils are fairly deep and not rocky, with good moisture-holding capacity due to the loam and fine sandy loam textures and the deep (average 35 cm) A1 soil horizons. Soil compaction can be a big problem, even when equipment operates on dry soils. These sites are so droughty that any reduction in infiltration ability and water-holding capacity can make the sites too dry to support continuous coniferous cover.

Number of Soil Pits:	2
Effective Soil Depth (cm):	63
Soil Surface Texture:	Loam, or fine sandy loam
Parent Materials:	Basalt or ash

Similar Associations

This association differs from ABGR/SYMPH because it has almost no grand fir seedlings and is too dry to support mature grand fir. PSME/SYAL is similar to the PIPO-PSME/SYMPH (Mutton Area) association described for the Warm Springs Indian Reservation (Marsh, personal communication). PSME/SYAL indicates considerably drier environments and lacks the grand fir-white fir component abundant in the Mixed conifer/snowberry/forb and Mixed conifer/Snowberry/Twinflower Flatlands associations described by Volland (1985) for the northern portion of the Deschutes National Forest. The PIPO-PSME/SYAL-HODI association of the Blue Mountains (Hall 1973) is not very similar. The PSME/SYAL habitat types for Idaho (Cooper and others 1987) and Montana (Pfister 1977) are quite similar but have additional Rocky Mountain species. The PSME/SYAL(OKA) association on the Okanogan NF (Williams and Lillybridge 1983) is also somewhat similar to this association.

Grand fir/Elk Sedge
Abies grandis/Carex geyeri
ABGR/CAGE CWG1 21

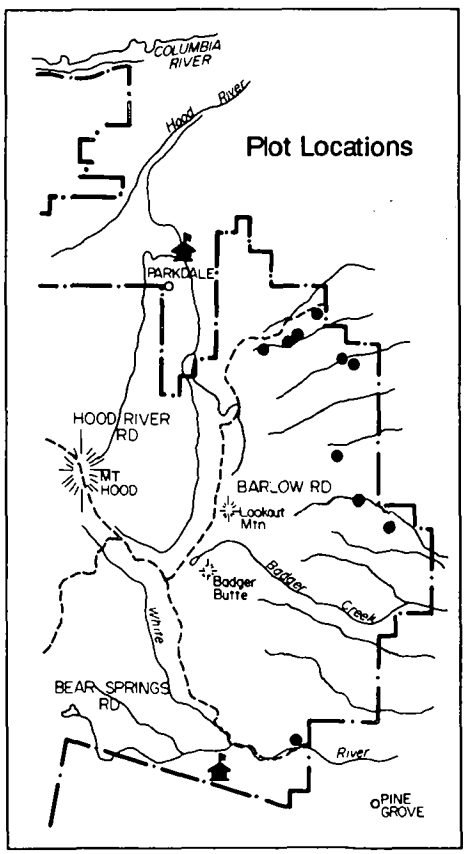


Environment and Distribution

This association includes the hottest and driest sites in the grand fir series. This association is widespread on the Barlow Ranger District but rare elsewhere except the eastern edge of the Hood River Ranger District. Plots are primarily north of Ramsey Creek, at elevations ranging from 2380 to 3600 feet. Aspects are mostly southerly, from southeast to southwest, but we sampled one very low elevation (2380 feet) plot with a north aspect.

	Range	Average
Elevation (ft):	2380-3600	2936
Precipitation (in/yr):	28-60	37
Slope (%):	4-45	30

Number of Plots:	11 (intensive = 8)
Common Aspects:	Variable
Topographic Positions:	Various slopes



Vegetation: Structure and Composition

Douglas-fir (PSME) dominates the mixed conifer stands typical for this association. Both mature and seedling grand fir (ABGR) are present, though they comprise a minor portion of the canopy. Large, old ponderosa pine (PIPO) are common, over-topping Douglas-fir which are frequently about 80 years old. Old growth Douglas-fir stands of this association are found. Some stands in this association have a few Douglas-fir seedlings, but in the absence of disturbance, grand fir eventually dominates. Oregon white oak (QUGA) is the only other tree species found, but only in small amounts. Elk sedge (CAGE) and snowberry (SYAL or SYMO) dominate the understory. Dry-site shrubs are common, but in small amounts, including oceanspray (HODI) and tall Oregongrape (BEAQ). Many herb species occur in this association but with much less cover than elk sedge. Common grass species are Idaho and western fescue (FEID and FEOC), and oniongrass (MEBU).

Dominant Vegetation

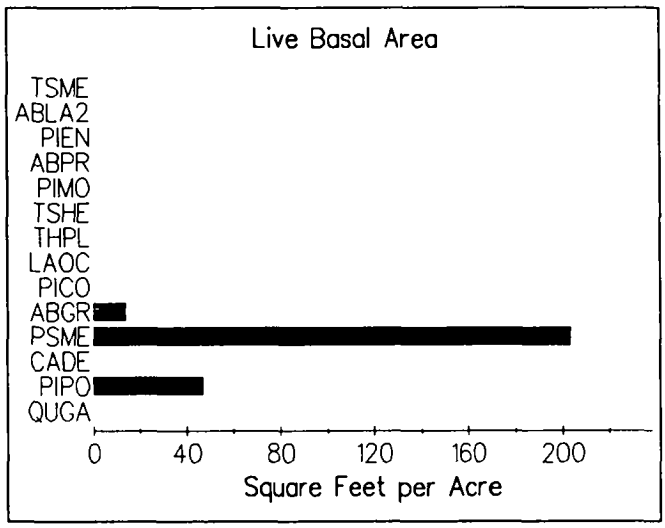
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	48	100
Grand fir	ABGR	7	100
Ponderosa pine	PIPO	7	81
Oregon white oak	QUGA	2	27
Understory Trees			
Grand fir	ABGR	3	90
Oregon white oak	QUGA	1	45
Douglas-fir	PSME	3	36
Shrubs			
Snowberry	SYMPH	15	81
Tall oregongrape	BEAQ	2	81
Oceanspray	HODI	2	63
Baldhip rose	ROGY	1	63
Forbs			
Sweet-cicely	OSMOR	2	91
Woods strawberry	FRVE	2	82
Bigleaf sandwort	ARMA3	2	72
Star-flower	TRLA2	3	54
Grasses & Sedges			
Elk Sedge	CAGE	24	100
Western fescue	FEOC	4	72
Idaho fescue	FEID	1	45
Oniongrass	MEBU	2	36

Timber Productivity and Management

This association includes stands moderately low in timber productivity. Stocking, site indices and growth basal area are generally lower than the other grand fir series plant associations. Sites are generally so dry that clearcuts may be difficult to regenerate. If used, clearcut unit size and shape should be oriented to maximize shade. When shelterwoods are planted with ponderosa pine, the remaining Douglas-fir overstory will shade the site and provide seed, thereby re-establishing a mixture of ponderosa pine and Douglas-fir.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	91	8.0	204	32.7	6.4	1.4
PSME	100	107	5.1	244	22.1	12.1	1.0
ABGR	50	91	6.7	258	38.1	13.9	0.4

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
90	7.1	100	13.9	303	82.0	407	42.9



Wildlife and Range

Forage production is fairly high in this association and it serves cattle well. Big game also utilize this forage, as well as the fairly abundant shrub species, such as oceanspray and baldhip rose (ROGY). The large ponderosa pine and occasional large snags provide important habitat for many wildlife species. Merriam's wild turkey successfully nest in thinned, pole-sized stands like those common in this association. Because moisture is so limiting in this association, tree planting and forage seeding should be carefully coordinated. Persistent and rhizomatous forage grasses (eg. orchardgrass or hard fescue) can take-over regeneration units and prevent conifer establishment. Minimizing ground disturbance activities, such as machine piling or slash burning, may be a better way to control erosion than grass seeding.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
18	0	2	8	8

Fuels Management

Leaving coarse woody debris on-site is desirable whenever compatible with fire risk evaluations. Long-term site productivity is reduced when machine-piling of slash displaces duff or compacts soils. Fuel loading on plots in this association was higher than that found in the Douglas-fir series, but lower than that in most of the grand fir series. Elk sedge resprouts readily following broadcast burns.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total # /acre	20"+ Dia. # /acre	12-19" Dia. # /acre
696	7.00	201	1.4	4.4

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.86	2.20	2.17

Soils

Soils are relatively rock-free and deep, composed primarily of fine sandy loam textured volcanic ash. Low incident precipitation levels and low moisture holding capacity are the reasons for the low moisture status of sites in this association. Sample pits had deep A1 soil horizons (average 44 cm), yet the shallow effective soil depth (average 44 cm) negatively impacts the soil moisture regime.

Number of Soil Pits:	8
Effective Soil Depth (cm):	44
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt, or ash on conglomerate, or basalt

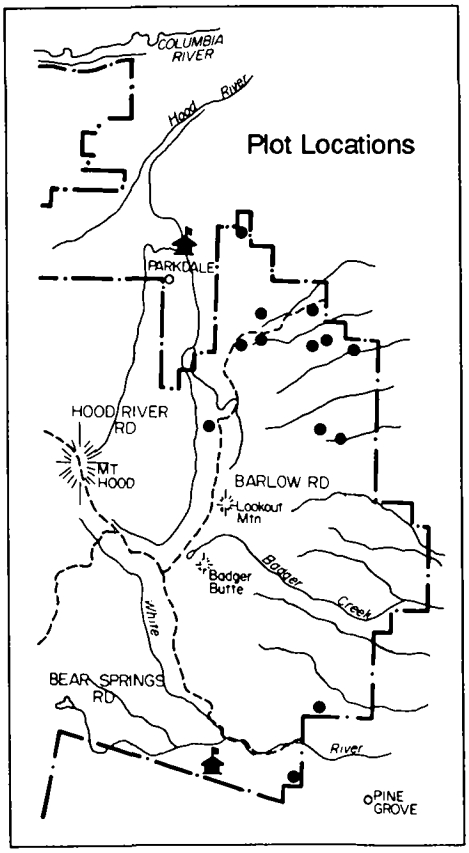
Similar Associations

This association differs from PSME/HODI/CAGE by having abundant grand fir regeneration in existing stands and by the greater vigor of large grand fir individuals. The ABGR/CAGE association for the Badger Allotment, Barlow RD, is very similar to this association (Williams 1978). The Mixed conifer/Snowberry/Elk sedge type described for the Warm Springs Indian Reservation includes many stands like this association (Marsh 1985).

Grand fir/Oceanspray
Abies grandis/Holodiscus discolor
ABGR/HODI CWS5 31

Environment and Distribution

Sites represented by this association are hot and dry. This association is widespread on the northern half of Barlow Ranger District and exposed sites on the eastern edge of Hood River RD. Sites are dry either because they are on south aspects with shallow soils, or they have low precipitation. Most sites having this association are above 3000 feet in elevation. Plots are as high as 3840 feet, but these are rocky and have south or west aspects, both important factors adversely influencing soil moisture supplying capacity. Northerly aspects occur at lower elevations where low precipitation is the rule. Average precipitation was 49 inches/year; this value is inflated by some higher elevation plots (3700) having high rainfall values.



	Range	Average
Elevation (ft):	2375-3840	3132
Precipitation (in/yr):	27-91	49
Slope (%):	4-60	28
Number of Plots:	13 (intensive = 7)	
Common Aspects:	Variable	
Topographic Positions:	Mid and upper slopes	

Vegetation: Structure and Composition

This association is the most shrub-rich of the grand fir series. Douglas-fir (PSME) and ponderosa pine (PIPO) with lesser amounts of grand fir (ABGR), dominate these mixed conifer stands. Other tree species are usually absent except for trace amounts of western larch (LAOC) and lodgepole pine (PICO). Grand fir dominates the regeneration layer, and even though Douglas-fir seedlings occur, grand fir will eventually dominate in the absence of fire. Samples include several old-growth Douglas-fir stands having trees up to 275 years old. Shrub cover may be dense and tall, including such dry-site species as oceanspray (HODI), snowberry (SYAL and SYMO), baldhip rose (ROGY), California hazel (COCO2), serviceberry (AMAL) and white spirea (SPBE). Rocky mountain maple (ACGLD) and creeping hollygrape (BERE), two dry-site indicators, are also common. Grasses (western fescue (FEOC) and Columbia brome (BRVU)) as well as elk sedge (CAGE) have high constancy, but low cover. Forb species characteristic of both dry and mesic forests grow in small amounts. The former include Nuttall's peavine (LANE), yellow hairy hawkweed (HIAL2) and tailcup lupine (LUCA), whereas the latter include Scouler's bellflower (CASC2), starflower (TRLA2), false solomonseal (SMRA) and white hawkweed (HIAL).

Dominant Vegetation

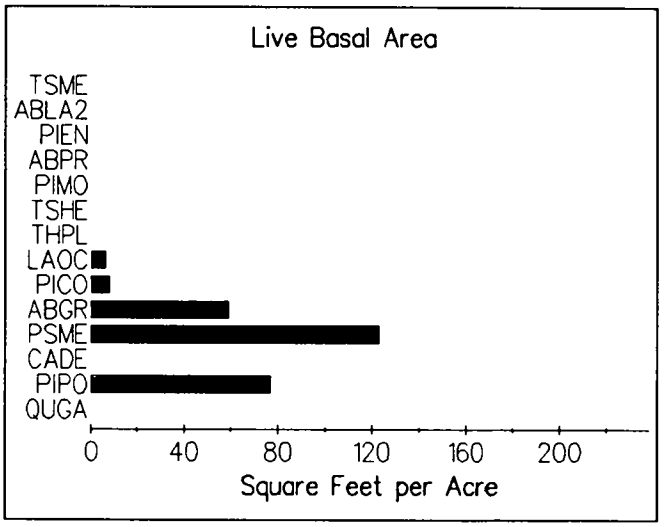
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	44	100
Grand fir	ABGR	9	100
Ponderosa pine	PIPO	14	84
Understory Trees			
Grand fir	ABGR	5	100
Douglas-fir	PSME	2	38
Shrubs			
Oceanspray	HODI	5	100
Snowberry	SYMPH	14	92
Baldhip rose	ROGY	4	92
California hazel	COCO2	5	61
Tall oregongrape	BEAQ	3	61
Serviceberry	AMAL	2	61
White spirea	SPBE	2	61
Rocky mountain maple	ACGLD	9	30
Forbs			
Woods strawberry	FRVE	2	92
Star-flower	TRLA2	2	76
Scouler's bellflower	CASC2	2	69
Bigleaf sandwort	ARMA3	2	62
Sweet-cicely	OSMOR	1	69
False solomonseal	SMRA	1	46
Grasses & Sedges			
Western fescue	FEOC	2	69
Elk Sedge	CAGE	4	61
Columbia brome	BRVU	1	61

Timber Productivity and Management

This association can be quite productive for timber once stands are established. Sampled stands have good stocking and fairly good tree height growth (average Douglas-fir site index = 118). Intense heat and droughty soils make clearcuts difficult to regenerate. Small units with some shading from surrounding trees can help alleviate transpirational demands of seedlings. Douglas-fir can be successfully regenerated by shelterwood harvest. Ponderosa pine is generally the first choice to plant in clearcuts, especially in exposed sites having this association.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	93	8.8	263	49.2	9.0	1.6
PSME	100	118	2.7	292	27.1	15.6	2.2
ABGR	50	81	4.2	405	101.0	18.5	2.2

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
105	3.9	115	17.7	266	45.8	399	49.4



Wildlife and Range

Abundant browse makes this association particularly useful to big game and many other wildlife species. Some stands having this association provide winter range. Seeded grass may increase available forage, though persistent or rhizomatous species (eg. orchardgrass or hard fescue) may compete vigorously with young conifers. The native shrub and herb populations re-establish rapidly following disturbance and provide excellent browse and forage. Erosion control of severly impacted sites can be achieved with cereal rye, a non-persistent species. Ponderosa pine and Douglas-fir can grow to large sizes and provide important wildlife habitat as snags.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
38	1	4	14	19

Fuels Management

Machine piling and slash burning need to be conducted with great care in these dry sites. Removal of surface organic matter can reduce the site's ability to infiltrate and hold water. Large woody debris also provides shaded microsites for seedlings, helps hold soil in place on steep slopes, acts as a substrate for nitrogen-fixing bacteria, and when incorporated into the soil and decayed, provides moisture for mycorrhizae. Fuel loadings were the lowest of any grand fir series association. Desirable native browse and forage species resprout following cool broadcast burns but we suspect they are eliminated by hot burns.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
396	4.43	380	0.0	2.6

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.72	2.20	2.21

Soils

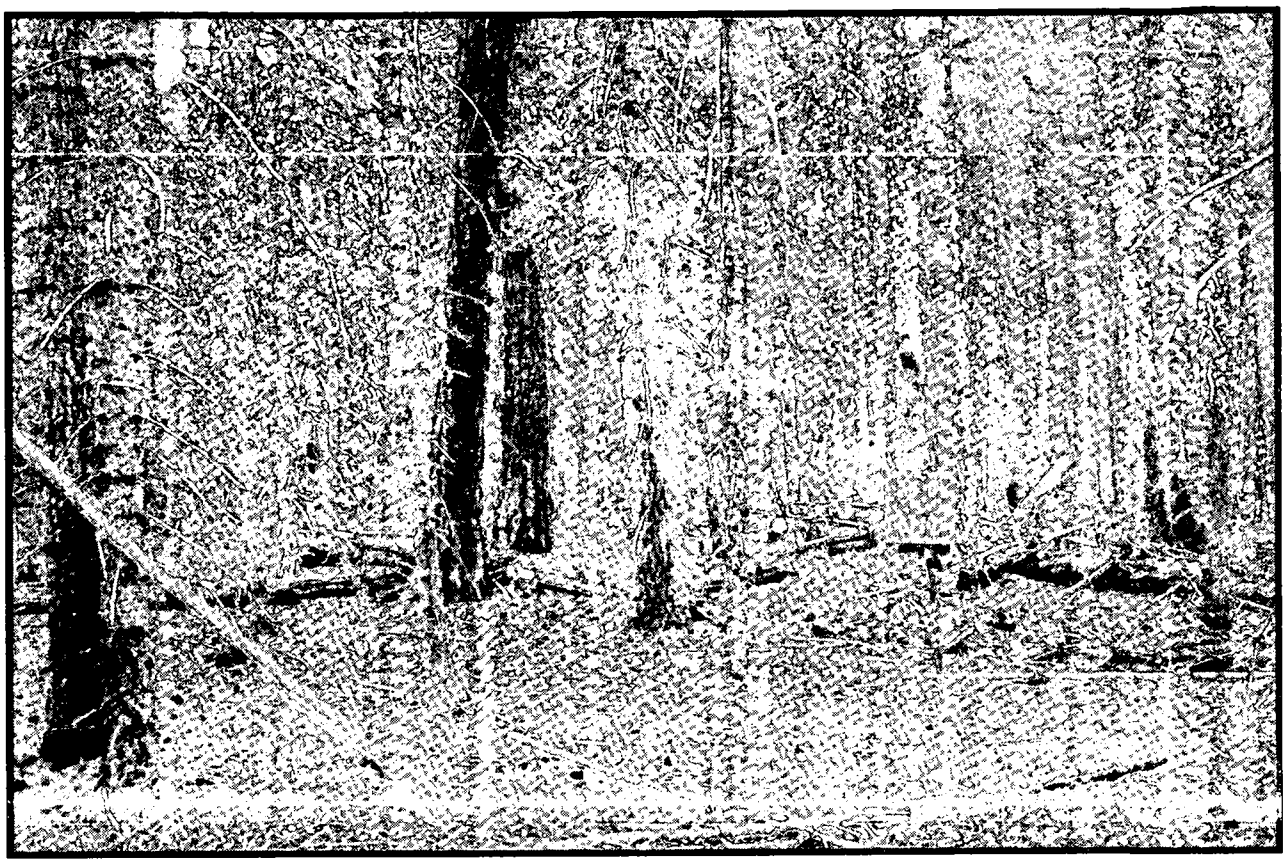
Typical Mt. Hood National Forest eastside soils of fine sandy loam textured volcanic ash are characteristic of this association. The effective soil depth of 61 cm is quite good for the grand fir zone.

Number of Soil Pits:	9
Effective Soil Depth (cm):	61
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt, or ash on conglomerate

Similar Associations

This association differs from PSME/HODI/CAGE in that the latter nearly lacks grand fir. ABGR/HODI is more rich in tall shrub species, such as oceanspray, California hazel and serviceberry, and more restricted in geographical distribution than the ABGR/SYMPH association. Similar Associations were not described for the Badger Allotment (Williams 1978) nor the Warm Springs Indian Reservation (Marsh 1985).

Grand fir/Snowberry
Abies grandis/Symphoricarpos
ABGR/SYMPH CWS3 31

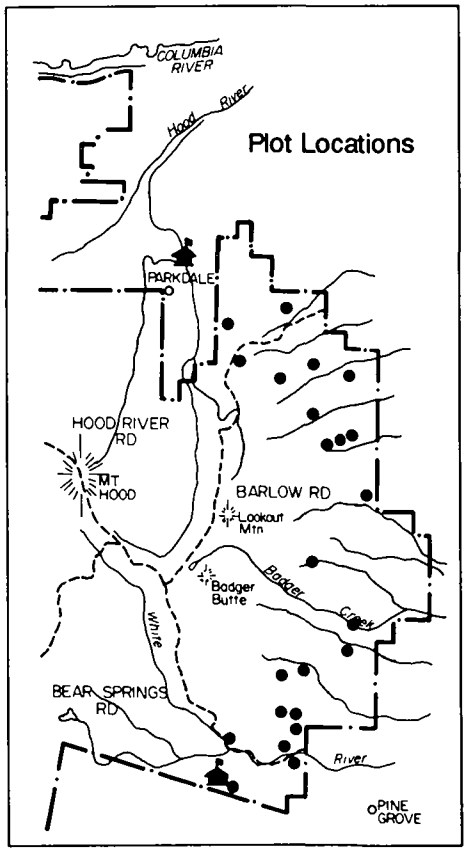


Environment and Distribution

This very common association indicates hot and dry environments. Elevations are usually between 2600 and 3200 feet, but sites occur as high as 3900 feet in exposed locations. This association is common across the lower grand fir zone of the Barlow Ranger District and occurs sporadically on the eastern portions of Bear Springs and Hood River Ranger Districts. Slopes are gentle, rarely over 25%. Precipitation is low; only a few high elevation plots have values greater than 40 inches per year.

	Range	Average
Elevation (ft):	2220-3920	3059
Precipitation (in/yr):	26-92	40
Slope (%):	2-50	14

Number of Plots:	24 (intensive = 12)
Common Aspects:	Variable
Topographic Positions:	Flats and upper slopes



Vegetation: Structure and Composition

This association includes mixed conifer forests having either common snowberry (SYAL) or creeping snowberry (SYMO) as the dominant understory species. Douglas-fir (PSME), grand fir (ABGR), and ponderosa pine (PIPO) dominate the overstory. Often the grand fir comprises a minor portion of the overstory, but it is the major seedling species present. Western larch (LAOC) is at the edge of its environmental tolerance. Sample stands date from the early 1900's, except the ponderosa pine are frequently older than the other trees. These stands have become more densely stocked than would occur in a natural fire regime with frequent, low intensity underburns. The exclusion of fire has allowed grand fir populations to increase. Some stands in this association have very sparse understories with little other than snowberry. Other sites have a more diverse flora. Substantial cover of snowberry may be accompanied by small amounts of baldhip rose (ROGY), oceanspray (HODI), serviceberry (AMAL), California hazel (COCO2), tall Oregongrape (BEAQ) and creeping hollygrape (BERE). The forb and grass layer is usually sparse and patchy, though diverse.

Dominant Vegetation

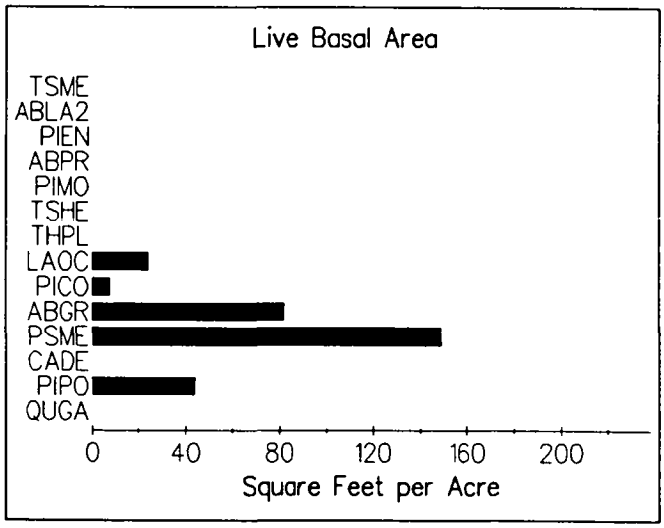
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	39	100
Grand fir	ABGR	23	100
Ponderosa pine	PIPO	13	79
Understory Trees			
Grand fir	ABGR	4	83
Douglas-fir	PSME	2	33
Shrubs			
Snowberry	SYMPH	9	100
Baldhip rose	ROGY	2	70
Oceanspray	HODI	2	50
Serviceberry	AMAL	2	45
Creeping hollygrape	BERE	2	37
Forbs			
Sweet-cicely	OSMOR	1	79
Woods strawberry	FRVE	1	71
Bigleaf sandwort	ARMA3	2	62
Scouler's bellflower	CASC2	2	50
Star-flower	TRLA2	2	50
Oregon anemone	ANOR	1	50
Grasses & Sedges			
Western fescue	FEOC	1	41
Elk Sedge	CAGE	2	29

Timber Productivity and Management

Productivity is quite substantial for such dry sites. Plots had both good stocking (average total basal area = 255 ft^2/acre) and height growth (average Douglas-fir site index = 118). Large ponderosa pine are fairly common. Much of the area containing this association has had some form of timber entry, either to selectively harvest ponderosa pine, or to salvage mortality. Spruce budworms had defoliated the upper 1/3 of many Douglas-fir trees during 1986. Although tree growth is good, tree establishment is difficult. Shelterwood harvests are an effective way to ameliorate the hot and dry environments. Douglas-fir can regenerate in this manner. Planting ponderosa pine is also appropriate. Successful clearcut regeneration is more likely in small units situated to maximize shade.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	101	3.0	240	24.1	9.2	1.2
PSME	100	118	3.7	281	14.5	12.0	0.7
ABGR	50	77	4.1	279	11.6	12.7	1.3

Yield Capacity ft^3/ac/yr		SDI Growth Estimate ft^3/ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
105	5.1	119	8.2	286	34.8	418	22.7



Wildlife and Range

Range value for wild and domestic ungulates is primarily as transitory range following site disturbance. Pasture and rhizomatous grasses will grow well and can provide forage for livestock and big game, yet fairly small quantities may be sufficient to out-compete conifer seedlings for water. Some of the land included in this association is winter range and has shrub and grass forage of high quality, albeit usually small quantity. Commercially thinned stands offer a good opportunity for transitory range benefiting both livestock and big game. Merriam's wild turkeys nest very successfully in thinned, pole-sized stands such as those common to this association. Larger snags (> 20 inch diameter), almost all Douglas-fir, were common on sample plots.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
35	2	7	10	16

Fuels Management

Plots in this association had higher fuel loadings (12 ton/ac) than the other dry-site plant associations of the grand fir or Douglas-fir series. Slash disposal by machine piling is easy because gentle slopes prevail in this association, but soil compaction and surface organic matter displacement detract from long-term site productive potential. Slash provides important shade for seedlings, nesting sites for wildlife (eg. Merriam's wild turkey), and if incorporated into the soil to decay, vital moisture holding capacity for rooting and mycorrhizae.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
1149	12.0	314	4.7	8.6

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.70	2.39	2.93

Soils

Soils are very typical for the eastern portion of the Mt. Hood National Forest. Relatively deep, volcanic ash of fine sandy loam texture prevails. These soils are easily compacted by heavy equipment because the predominant gentle slopes allow easy access. Such damage is especially harmful in this association because the minimum soil moisture threshold allowing tree establishment is easily crossed.

Number of Soil Pits:	12
Effective Soil Depth (cm):	53
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt

Similar Associations

This association is similar to ABGR/HODI but the latter has much more oceanspray. This association is similar to the lower elevation portion of the ABGR/PAMY community described for the Badger Allotment, Barlow RD (Williams 1978). The Mixed conifer/Snowberry association on the Warm Springs Indian Reservation is quite similar but more broadly defined than this association. The Mixed Conifer/Snowberry/Forb association of the Central Oregon Pumice zone occurs at higher elevation, more mesic sites (Volland 1985). The ABGR/SPBE habitat types of northern Idaho (Cooper and others 1987) and Montana (Pfister and others 1977) share environmental and floristic affinities with this association.

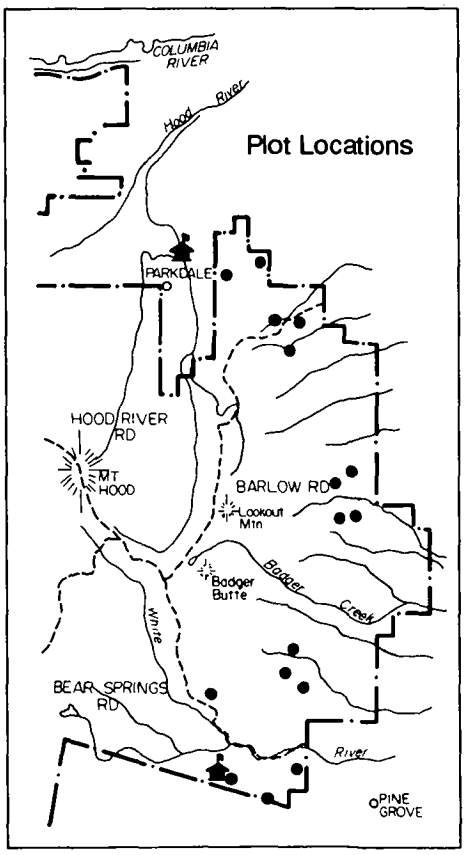
Grand fir/Starflower
Abies grandis/Trientalis latifolia
ABGR/TRLA2 CWF5 21

Environment and Distribution

This association indicates fairly dry environments,but has average moisture relative to the rest of the Grand fir zone. It is widespread throughout the middle portion of the Barlow Ranger District, the eastern part of Hood River Ranger District, and near the White River on Bear Springs Ranger District. It occurs on all aspects . Slopes less than 20 per cent prevail although steep sites do occur. Summer drought is long; snow packs do accumulate each year but melt early each spring.

	Range	Average
Elevation (ft):	2650-4100	3384
Precipitation (in/yr):	25-82	45
Slope (%):	3-50	17

Number of Plots:	16 (intensive = 9)
Common Aspects:	Variable
Topographic Positions:	Various slopes



Vegetation: Structure and Composition

Douglas-fir (PSME) and grand fir (ABGR) dominate the upper tree canopy, though ponderosa pine (PIPO) may also be abundant. Western larch (LAOC) and more rarely, western redcedar (THPL) and western hemlock (TSHE) also occur. Oregon white oak (QUGA) is virtually absent. The ponderosa pine are usually much older than the grand fir. Before fire suppression activities began in the early 1900's, stands in this association were primarily ponderosa pine and Douglas-fir, but included some grand fir. Subsequently grand fir have grown from beneath. The shrub layer may contain dense patches of vine maple (ACCI). Other shrubs are rarely abundant. All three Oregon grape species (BEAQ, BENE, and BERE) can be found. Western fescue (FEOC) is the only grass species abundant in this association. Forbs generally cover less than 10% of the ground surface. Major forb species are starflower (TRLA2), Oregon anemone (ANOR), Scouler's bellflower (CASC2), woods strawberry (FRVE), twinflower (LIBO2), white hawkweed (HIAL) and rattlesnake plantain (GOOB). The dry-site indicating herb, rayless arnica (ARDI), is common, whereas a more moist-site indicator, vanillaleaf (ACTR), is nearly absent.

Dominant Vegetation

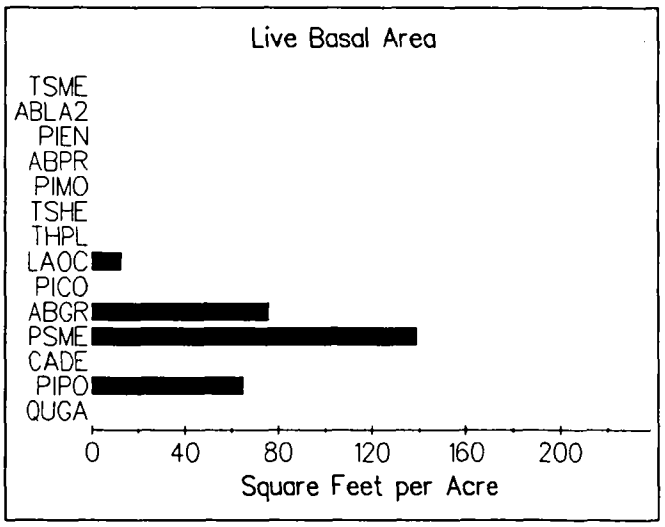
	Code	%Cov	Cons
Overstory Trees			
Grand fir	ABGR	33	100
Douglas-fir	PSME	28	100
Ponderosa pine	PIPO	11	75
Western redcedar	THPL	6	12
Understory Trees			
Grand fir	ABGR	3	87
Douglas-fir	PSME	9	12
Shrubs			
Snowberry	SYMPH	4	93
Baldhip rose	ROGY	1	87
Vine maple	ACCI	19	50
Little prince's pine	CHME	1	81
Rocky mountain maple	ACGLD	4	18
Golden chinkapin	CACH	2	18
Forbs			
Star-flower	TRLA2	2	100
Scouler's bellflower	CASC2	2	75
Oregon anemone	ANOR	1	68
White hawkweed	HIAL	1	68
Woods strawberry	FRVE	1	63
Twinflower	LIBO2	1	43
Grasses & Sedges			
Western fescue	FEOC	1	43

Timber Productivity and Management

Timber productivity in this association is moderate when compared to the rest of the grand fir zone. Mature stands are well stocked and have fair to good height growth. Douglas-fir site index averaged 119 but was quite variable. Stand regeneration can be difficult because of the dry and hot environments. Clearcuts should be designed to maximize shading from surrounding stands. Large down wood also can aid regeneration by providing many shaded microsites for seedling establishment. Ponderosa pine is the preferred species to plant in clearcuts; Douglas-fir is good in shelterwoods. Douglas-fir seed trees left in shelterwood harvests should in many cases provide adequate natural regeneration. This is the driest association in which western larch is an appropriate species to plant in clearcuts. Pocket gophers may be sufficiently abundant to make conifer re-establishment difficult.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	98	5.5	177	15.4	7.8	1.6
PSME	100	119	5.5	298	24.6	13.1	0.7
ABGR	50	78	4.3	337	35.4	14.4	1.4

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
106	7.4	141	13.5	461	99.4	494	32.3



Wildlife and Range

Transitory range offers most of the forage production for wildlife and livestock in this association. Few sites have winter range value. Grass seeding should be avoided or minimized following clearcutting if timber re-establishment is a goal. Plots had abundant snags, primarily Douglas-fir, but also lesser amounts of ponderosa pine and western larch.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
38	4	7	21	7

Fuels Management

High fuel loadings on sample plots result from self-thinning processes of stands as grand fir grow-up from beneath. Sites in this association are sufficiently dry that coarse woody debris serves an important role as shade for seedlings. Careful machine piling of slash is required to minimize soil compaction and protect soil-surface organic matter accumulations.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
1237	12.6	281	2.1	16.2

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.66	1.96	3.36

Soils

The soils of this association are very typical for this area. Volcanic ash materials of fine sandy loam textures provide good moisture holding capacity. Effective soil depth (50 cm) is average for the grand fir zone. The gentle slopes make use of heavy equipment possible, but soils are easily compacted.

Number of Soil Pits:	11
Effective Soil Depth (cm):	50
Soil Surface Texture:	Fine sandy loam or silt loam
Parent Materials:	Ash on basalt

Similar Associations

This association is very similar to ABGR/LIBO2 but the latter has very little vine maple and is more frequently found in cool air drainages. This association includes sites which comprise a subset of those in the ABGR/PAMY community described for the Badger Allotment, Barlow RD (Williams 1978). An association described on Warm Springs Indian Reservation (ABGR/LIBO2) is quite similar (Marsh 1985). The Mixed conifer/snowberry/forb association of the Central Oregon Pumice zone is similar but frequently occurs on higher elevation, more mesic sites than does ABGR/TRLA2 (Volland 1985).

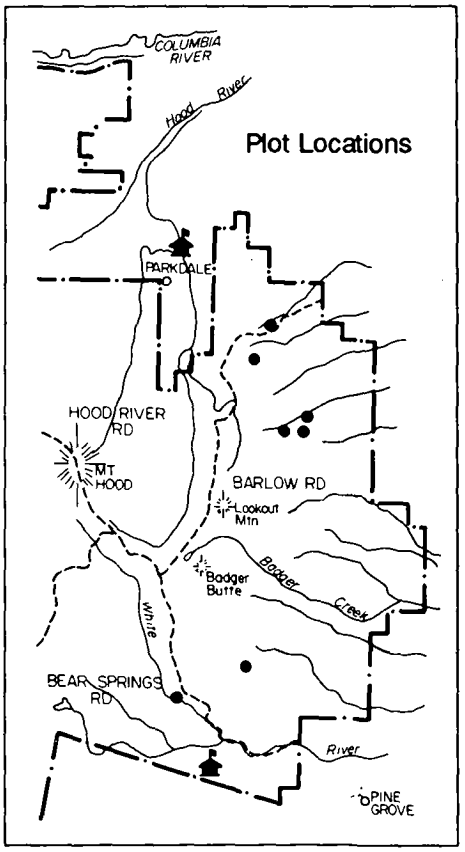
Grand fir/Twinflower
Abies grandis/Linnaea borealis
ABGR/LIBO2 CWF3 21

Environment and Distribution

This association is found at moderate elevations on all three eastside Mt. Hood National Forest Ranger Districts. It is generally restricted to areas below 4100 feet in elevation. During the growing season, these sites may experience daily temperature fluctuation, with hot, dry days and cold nights (due to cold air accumulation or radiation heat loss). Sites receive moderate precipitation. Snow accumulations help prolong the period of available soil moisture for plant growth.

	Range	Average
Elevation (ft):	3050-4180	3700
Precipitation (in/yr):	49-73	62
Slope (%):	1-48	21

Number of Plots:	7 (intensive = 3)
Common Aspects:	North and east
Topographic Positions:	Mid and upper slopes



Vegetation: Structure and Composition

This association includes relatively shrub-poor, closed canopy, mixed conifer stands. Nine coniferous species were encountered on sample plots. Douglas-fir (PSME) and grand fir (ABGR) dominate the canopies. Western larch (LAOC) achieves its greatest average live basal area in this association of any described in this guide. Lodgepole pine (PICO) is common and may even dominate the canopy in young, fire-initiated stands. Ponderosa pine (PIPO), western white pine (PIMO), western hemlock (TSHE), Engelmann spruce (PIEN), and western redcedar (THPL) add to the coniferous mix typical for this association. These forests have gradually had increases in grand fir abundance since the advent of fire suppression early this century. Shrub growth is usually fairly sparse. Twinflower (LIBO2) is the most abundant herb species, though even it rarely covers more than 10% of the ground in mature stands. Frequently there are traces of several mesic-site herbs (vanillaleaf (ACTR), and false and starry Solomonseal (SMRA and SMST)). Several species typical for mesic, closed Cascadian forests are common, including Prince's pine (CHUM and CHME), rattlesnake plantain (GOOB), whitevein and sidebells pyrola (PYPI and PYSE) and Oregon boxwood (PAMY). This is the driest and lowest elevation association where big huckleberry (VAME) is common, but only in traces.

Dominant Vegetation

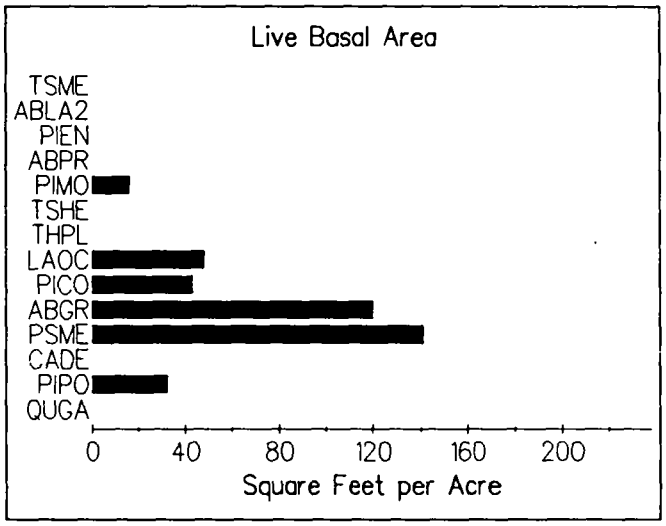
	Code	%Cov	Cons
Overstory Trees			
Grand fir	ABGR	24	100
Douglas-fir	PSME	21	100
Western larch	LAOC	3	71
Lodgepole pine	PICO	12	57
Ponderosa pine	PIPO	11	42
Western hemlock	TSHE	4	42
Western white pine	PIMO	3	42
Understory Trees			
Grand fir	ABGR	4	100
Shrubs			
Baldhip rose	ROGY	2	100
Little prince's pine	CHME	1	100
Snowberry	SYMPH	5	85
Oregon boxwood	PAMY	1	85
Rocky mountain maple	ACGLD	4	71
Big huckleberry	VAME	1	71
Dwarf oregongrape	BENE	11	42
White spirea	SPBE	11	42
Forbs			
Twinflower	LIBO2	5	100
Vanillaleaf	ACTR	1	85
Star-flower	TRLA2	2	85
Oregon anemone	ANOR	1	85

Timber Productivity and Management

Timber productivity is moderate in this association. Sampled stands had the highest stocking, both in terms of number of trees per acre and live basal area, of any grand fir series association. Small trees (< 6 inch DBH) were particularly abundant. Various silvicultural harvest systems can be used successfully. Shelterwoods which leave Douglas-fir as seed trees can frequently be regenerated naturally. Clearcuts may be planted with mixtures of ponderosa pine, Douglas-fir and western larch. At higher elevations, clearcuts on benches surrounded by timber may create frost pockets.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	107	-	318	-	8.7	-
PSME	100	108	8.2	281	83.9	8.9	1.6
ABGR	50	69	6.1	257	26.4	9.7	1.1

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
91	11.7	160	6.2	1179	684	676	87.8



Wildlife and Range

Forage production in the typical closed forests of this association is low, but these sites are very productive as transitory range. Few sites are useful as winter range. This association includes many sites near major streams where animal migrations may be important. Optimal thermal cover is thus critical. Tree thinning will stimulate the Rocky Mountain maple (ACGLD) which provides good deer browse. Seeded grass, such as hard fescue, timothy, orchardgrass or smooth brome, grows well but can take over regeneration units. Intensive plots had many snags, but almost all the larger ones (> 20 inch DBH) were grand fir, a species with low wildlife value and persistence.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
63	6	7	34	17

Fuels Management

Minimizing slash burning is less important in this association than in the drier-site types of the grand fir zone. Never the less, large woody debris and duff conservation is desirable to maintain and enhance long-term site productivity. Fuel loading on our sample plots was low considering the exceptionally high live tree stocking values. Hot prescribed burns will favor invasion of lodgepole pine over Douglas-fir, lowering future timber values.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
711	7.00	427	0	4.0

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.94	3.12	2.52

Soils

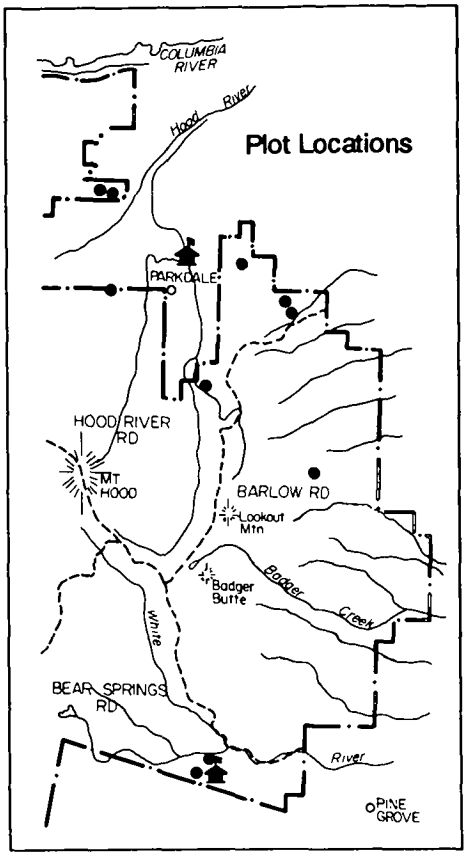
Relatively deep, stone-free soils of fine sandy loam textured ash prevail at sites supporting this association. Soils remain moist for longer periods than in much of the Grand Fir Zone, so soils are more readily compacted from heavy equipment use.

Number of Soil Pits:	6
Effective Soil Depth (cm):	55
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on varied rock types

Similar Associations

This association is very much like ABGR/TRLA2 but the latter has much more vine maple and tends to occur more widely at lower elevations. This association includes sites which are a subset of those included in the ABGR/PAMY community described for the Badger Allotment, Barlow RD (Willliams 1978). ABGR/LIBO2 habitat types in central Idaho (Steele and others 1981) and Montana (Pfister 1977) are quite similar to this association.

Grand fir/Vine maple/Vanillaleaf
Abies grandis/Acer circinatum/Achlys triphylla
ABGR/ACCI/ACTR CWS5 32



Environment and Distribution

This association indicates moderate sites for the grand fir zone. Gentle slopes (< 20%) are most common although some sites are on steep, exposed slopes. All aspects occur. This association is fairly common on the eastern and northern portions of Hood River Ranger District. It also occurs on the low elevation area at the north end of Bear Springs RD and occasionally at mid elevations on Barlow RD. Sites having this association are warm but receive more rain and snow than much of the grand fir zone.

	Range	Average
Elevation (ft):	1760-3800	3056
Precipitation (in/yr):	30-87	62
Slope (%):	9-40	20

Number of Plots:	10 (intensive = 6)
Common Aspects:	Variable
Topographic Positions:	Mid and upper slopes

Vegetation: Structure and Composition

Douglas-fir (PSME) and grand fir (ABGR) dominate the overstories in all stands. Grand fir seedlings regenerate abundantly in most stands. Occasional ponderosa pine (PIPO) share the canopies with western larch (LAOC), and tree-sized Pacific dogwood (CONU) and chinkapin (CACH). Most sites included in this association are quite brushy and may have small amounts of many herb species. Vine maple (ACCI) is always present and may be quite thick. Rocky Mountain maple (ACGLD) is less common. Mesic-site herbs include vanillaleaf (ACTR), pathfinder (ADBI), fairy bells (DIHO), and false and starry Solomonseal (SMRA and SMST). Starflower (TRLA2) is often the most abundant herb. Three-leaved anemone (ANDE) is common on Hood River Ranger District plots in this association whereas Oregon anemone (ANOR) occurs on Barlow and Bear Springs RD's. Grasses are generally absent except for traces of Columbia brome (BRVU).

Dominant Vegetation

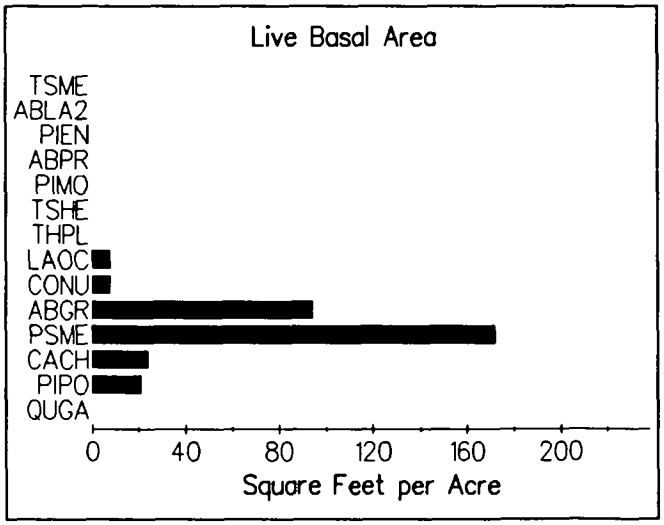
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	42	100
Grand fir	ABGR	26	100
Ponderosa pine	PIPO	4	30
Understory Trees			
Grand fir	ABGR	4	80
Shrubs			
Vine maple	ACCI	12	100
Snowberry	SYMPH	7	100
Baldhip rose	ROGY	2	100
Dwarf oregongrape	BENE	6	70
Trailing blackberry	RUUR	1	60
California hazel	COCO2	1	60
Oceanspray	HODI	2	40
Rocky mountain maple	ACGLD	7	30
Forbs			
Vanillaleaf	ACTR	2	100
Star-flower	TRLA2	4	100
Pathfinder	ADBI	1	70
Fairy bells	DIHO	2	60
Starry solomonseal	SMST	1	40
Three-leaved anemone	ANDE	1	40
Oregon anemone	ANOR	4	30

Timber Productivity and Management

Productivity is high in this association. Average site index (base age 100) for Douglas-fir was 131, the highest for any eastside plant association. Grand fir site index (base age 50) was also high (86). Forests in this association are well stocked but may have canopy openings occupied by patches of vine maple. This association includes sites which are hot and dry enough to make stand regeneration difficult. Clearcuts require design to maximize seedling shade. Shelterwoods are easier to regenerate in more exposed spots and on southerly aspects. Naturally regenerated Douglas-fir will likely need to be supplemented with planted Douglas-fir. Ponderosa pine grow well in clearcuts; they can be planted in a mixture with Douglas-fir. This association is marginal for western larch and western white pine, although these species may be planted on northern aspects.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	107	6.2	362	194	11.0	7.0
PSME	100	131	3.1	305	329	14.6	1.6
ABGR	50	86	2.4	264	24.4	13.7	2.6

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
121	4.0	131	8.5	221	43.3	403	32.4



Wildlife and Range

A diverse and palatable shrub and herb growth is typical in stands in this association. Deer and elk use is high for much of the year. Range for livestock is almost entirely transitory following management activities. Forage seeding may prolong the useful range period. Light seeding (2-4 lbs/acre) at most is recommended if conifer establishment and growth is also a resource objective. Some sites in this association receive heavy livestock use where water is available nearby. Large (> 20 in DBH) Douglas-fir snags provide abundant wildlife nesting sites.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
45	6	0	20	19

Fuels Management

Fuel loadings on intensive plots were very high. Hot broadcast burns may initiate dense ceanothus (snowbrush, CEVE) stands. Sites in this association are aided by large woody debris which provide shaded microsites, hold topsoil in place on steep slopes, are the substrate for nitrogen-fixing bacteria, and when incorporated into the soil to decay, increase soil moisture-holding capacity.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
1310	14.7	355	2.3	8.7

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.83	2.49	4.03

Soils

Soils may be quite rocky, but also may include a fair amount of ash with good moisture-holding capacity. The effective soil depth (60 cm) is good. Several sample plots have basalt or breccia-derived soils lacking the surface volcanic ash layers which are typical in the study area.

Number of Soil Pits:	8
Effective Soil Depth (cm):	60
Soil Surface Texture:	Fine sandy loam, or loam
Parent Materials:	Breccia on basalt, or ash on basalt

Similar Associations

This association is much more heavily vegetated with shrub species than is ABGR/ACTR. ABGR/LIBO2 and ABGR/TRLA2 also lack much shrub cover and lack such mesic-site herbs as vanillaleaf and false Solomon-seal which are common in ABGR/ACCI/ACTR. The ABGR/ACCI association on Warm Springs Indian Reservation is very similar to this association (Marsh 1985).

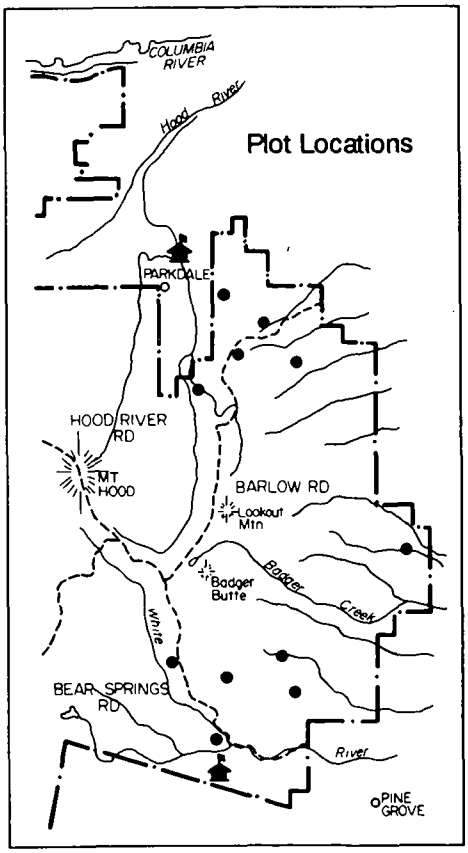
Grand fir/Vanillaleaf
Abies grandis/Achlys triphylla
ABGR/ACTR CWF5 22

Environment and Distribution

This association includes warm sites which are more moist than much of the Grand Fir Zone on the Mt.Hood National Forest. Stands are at mid elevations (3200 to 4000 feet) on Barlow, the eastern portion of Hood River and the northeastern part of Bear Springs Ranger Districts. All aspects were sampled although south is rare. Slopes vary; many sites occur on grades greater than 40 per cent. Snow packs accumulate each year, thereby decreasing the period of summer drought. Annual precipitation averages 63 inches per year on our plots.

	Range	Average
Elevation (ft):	3200-4000	3539
Precipitation (in/yr):	44-88	63
Slope (%):	5-60	27

Number of Plots: 10 (intensive = 7)
Common Aspects: Variable
Topographic Positions: Mid slopes



Vegetation: Structure and Composition

This association includes herb-rich, mixed conifer stands dominated by Douglas-fir (PSME) and grand fir (ABGR). Ponderosa pine (PIPO) appears as scattered, large individuals but is a minor component of mature stands. Other conifers occasionally present are lodgepole pine (PICO), western larch (LAOC), western hemlock (TSHE), noble fir (ABPR), or western white pine (PIMO). Mature stands have continuous canopies and are well stocked with trees. Shrub and herb layers are not dense but are often quite diverse. Rocky Mountain maple (ACGLD), white spirea (SPBE), baldhip rose (ROGY) and snowberry (either SYMO or SYAL) are usually present and are the most abundant shrubs. Any of three Oregongrape species can be encountered: tall (BEAQ), dwarf (BENE), and creeping hollygrape (BERE). Mesic-site herbs are common, including vanillaleaf (ACTR), pathfinder (ADBI), fairybells (DIHO), starflower (TRLA2), trillium (TROV) and false and starry Solomonseal (SMRA and SMST). The presence of at least two per cent cover of vanillaleaf is diagnostic for this association. Grasses are absent in undisturbed stands except for traces of Columbia brome (BRVU) and western fescue (FEOC).

Dominant Vegetation

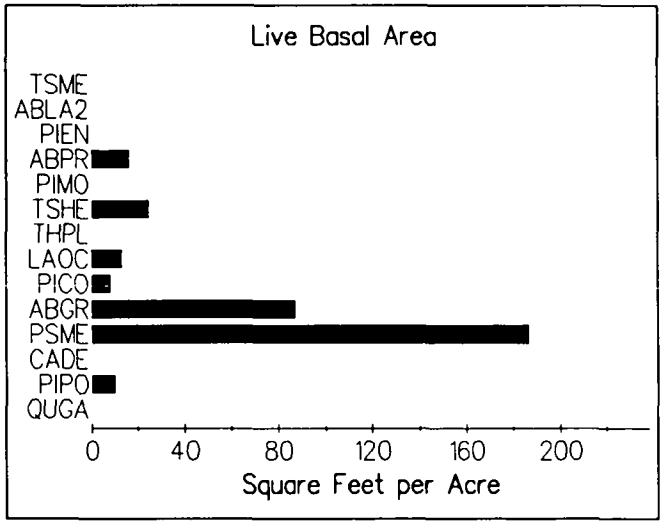
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	40	100
Grand fir	ABGR	25	50
Ponderosa pine	PIPO	2	30
Lodgepole pine	PICO	2	20
Understory Trees			
Grand fir	ABGR	6	90
Shrubs			
Snowberry	SYMPH	4	90
Baldhip rose	ROGY	2	90
White spirea	SPBE	2	80
Prince's pine	CHUM	1	90
Rocky mountain maple	ACGLD	3	60
Oregon boxwood	PAMY	1	60
Oceanspray	HODI	2	50
Thimbleberry	RUPA	1	50
Forbs			
Vanillaleaf	ACTR	7	100
Star-flower	TRLA2	3	100
Sidebells pyrola	PYSE	2	90
Trillium	TROV	1	90
Bigleaf sandwort	ARMA3	1	90
False solomonseal	SMRA	1	70
Woods strawberry	FRVE	1	70
Starry solomonseal	SMST	1	60
Pathfinder	ADBI	1	60

Timber Productivity and Management

This association is very productive for timber. Both Douglas-fir and grand fir can maintain very good height growth for more than a century. Douglas-fir site index, base age 100, averaged 127. This includes several stands with dominants over 100 years of age. Ponderosa pine also grows well here; it is silviculturally most useful on exposed south slopes or places with substantial laminated root rot *(Phellinus)*. Either clearcuts or shelterwoods can be regenerated with planted Douglas-fir. Natural regeneration of Douglas-fir should often occur in shelterwoods having this species as seed trees. Pocket gophers are common in mature stands and may cause regeneration failures in clearcuts. Gopher populations may be enhanced by seeding orchardgrass, hard fescue or smooth brome.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	127	5.4	365	22.8	11.5	1.0
ABGR	50	88	2.8	298	29.7	12.1	1.0

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
116	7.0	144	10.8	263	22.7	458	20.1



Wildlife and Range

This association includes upland forests having high value to a broad spectrum of wildlife. The large trees produced here can provide excellent nesting sites lasting many decades for many cavity dwellers. Intensive plots had some large (> 20 inch DBH) ponderosa pine snags. Big game browse is fairly abundant. Commercial thinning operations will stimulate brushy growth of Rocky Mountain maple, baldhip rose and thimbleberry; all are good deer browse. Transitory range is excellent for elk as well as livestock. Light seeding of mesic-site grasses (orchardgrass, smooth brome, hard fescue) enhances transitory range and should not out-compete well established conifer seedlings. Sites with this association get little winter range use.

Snags -Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
13	3	0	10	0

Fuels Management

The high fuel loadings on our intensive plots reflect the high timber productivity characteristic of this association. The productive nature of sites displaying this association can be damaged by soil compaction from logging equipment or machine slash piling. Cool slash burns which do not destroy all of the forest floor are an important part of efforts to maintain the high long-term site productivity. Large woody debris provide important shaded microsites for seedlings, help hold topsoil in place on steep slopes, are the substrate for nitrogen-fixing bacteria and mycorrhizae, and when decayed in the soil matrix, enhance soil moisture-holding capacity. Hot broadcast burns are likely to initiate dense snowbrush ceanothus (CEVE) stands.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
1074	11.0	191	6.0	4.6

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.91	2.36	3.34

Soils

Soils are generally deep, not rocky and include fine volcanic ash with good moisture-holding capacity. Fine sandy loam textures prevail near the soil surface. The effective soil depth (55 cm) indicates that soils have good physical properties for plant growth. In our chemically analyzed samples from The Dalles watershed, nutrient values tended to be low.

Number of Soil Pits:	9
Effective Soil Depth (cm):	55
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt; breccia, basalt

Similar Associations

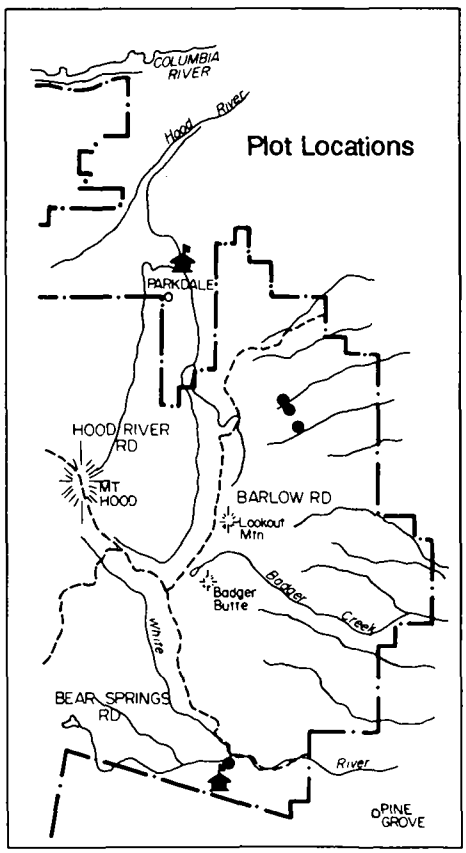
This association is quite similar to ABGR/ACCI/ACTR but the latter has much higher cover of several shrub species and soils which are more rocky and shallow. ABGR/ACTR has a greater abundance of mesic-site herbs, such as vanillaleaf and false Solomonseal, than either ABGR/TRLA2 or ABGR/LIBO2. The ABGR/ACCI association on Warm Springs Indian Reservation has much more vine maple and dwarf Oregongrape but otherwise is quite similar to this association (Marsh 1985). The ABGR/CLUN habitat type of Montana (Pfister and others 1977) indicates somewhat similar environments and has floristic affinities to this association.

Grand fir/Chinkapin
Abies grandis/Castanopsis chrysophylla
ABGR/CACH CWS5 33

Environment and Distribution

This association has limited distribution at moderate elevations on Barlow Ranger District, the eastern portion of Hood River RD, and the northeastern part of Bear Springs RD. Temperatures are warm and precipitation is moderate compared to the rest of the Grand fir zone. Snow packs usually persist into spring. Slopes and aspects vary greatly. Our sample plots were near major sheep drive trails used from 1910 to about 1930. These sites are 2-3 miles east of Brooks Meadow on Barlow RD and near Camas Creek on Bear Springs RD. It is possible that soil compaction, over-grazing and selective grazing by sheep have influenced the vegetation over the long term. This grouping may actually be a community type (not a climax plant association), but some old-growth stands were sampled so we prefer the "association" nomenclature.

	Range	Average
Elevation (ft):	3200-4200	3800
Precipitation (in/yr):	34-69	58
Slope (%):	10-48	24
Number of Plots:	4 (intensive = 1)	
Common Aspects:	Often north	
Topographic Positions:	Mid and upper slopes	



Vegetation: Structure and Composition

This association includes mixed conifer stands dominated by Douglas-fir (PSME), ponderosa pine (PIPO), and grand fir (ABGR). Lodgepole pine (PICO) is abundant in fire-initiated stands less than 100 years of age. This association includes sites near the hot/dry physiological limit for western larch (LAOC) and western white pine (PIMO). Grand fir has grown up from below in older stands following the advent of fire suppression earlier this century. A variety of shrub species grow, with chinkapin (CACH) or snowberry (either SYAL or SYMO) being dominant. Vine maple is infrequent but may occur in dense patches. Twinflower is common and may be extensive; it is often accompanied by vanillaleaf (ACTR) and other herbs.

Dominant Vegetation

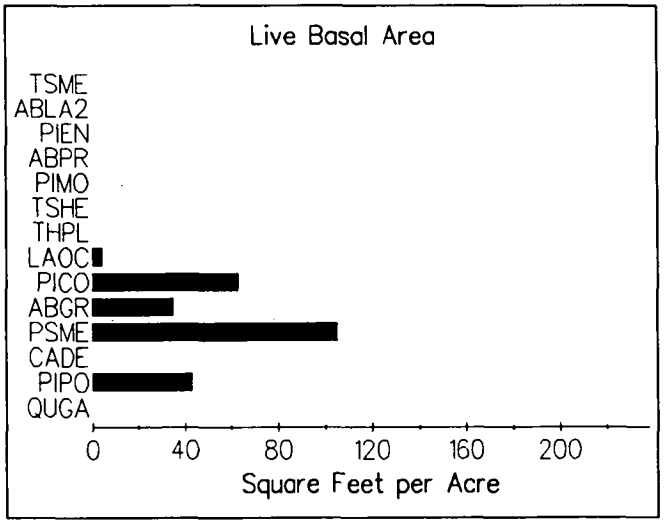
	Code	%Cov	Cons
Overstory Trees			
Grand fir	ABGR	22	100
Douglas-fir	PSME	23	75
Lodgepole pine	PICO	38	50
Western larch	LAOC	4	50
Ponderosa pine	PIPO	15	25
Understory Trees			
Grand fir	ABGR	7	100
Douglas-fir	PSME	7	75
Shrubs			
Snowberry	SYMPH	6	100
Golden chinkapin	CACH	5	100
Baldhip rose	ROGY	4	100
Prince's pine	CHUM	4	100
Forbs			
White hawkweed	HIAL	2	100
Twinflower	LIBO2	6	75
Vanillaleaf	ACTR	3	75
False solomonseal	SMRA	1	75
Woods strawberry	FRVE	1	75
Star-flower	TRLA2	3	50
Grasses & Sedges			
Western fescue	FEOC	1	75
Elk Sedge	CAGE	1	50

Timber Productivity and Management

Timber productivity is moderate to low in this association. Stocking and height growth are variable. The fairly young grand fir exhibit very good height and diameter growth. Douglas-fir should perform well when planted in clearcuts. Ponderosa pine is useful to help regenerate more exposed aspects and western larch can be used on more protected sites. Unless shelterwoods are planted with Douglas-fir, grand fir may dominate the future stand. Grand fir regenerates naturally once some conifer cover is established, and provides increased stand volume growth compared to single species stands.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	84	-	214	-	12.7	-

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
58	-	88	-	654	-	563	-



Wildlife and Range

Wildlife use of sites in this association is substantial. Many birds and small mammals eat chinkapin fruits. Mature stands have poor range value. Browse and forage for ungulates, including cattle, is substantial in transitory range following management activities. Seeded grass (such as orchardgrass, smooth brome or hard fescue) can out-compete conifer seedlings in regeneration units. Snags were absent from our intensive plots, but both ponderosa pine and Douglas-fir snags occurred on reconnaissance plots.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
0	0	0	0	0

Fuels Management

Fuel loading was low on our intensive plot in this association. Sites are sufficiently dry and exposed to benefit from surface organic matter which provides shade, soil insulation, and enhances soil water infiltration and long-term site productivity.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
841	9.00	165	0	0

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.51	1.92	0.75

Soils

Soils are typical for the eastern portion of the Mt. Hood National Forest. Fine sandy loam textured volcanic ash dominates the surface layers. A1 horizons were especially deep, averaging 47 cm, at our sample sites.

Number of Soil Pits:	3
Effective Soil Depth (cm):	53
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt

Similar Associations

This association is floristically similar to both ABGR/LIBO2 and ABGR/TRLA2 but it has more shrub cover, especially chinkapin. It also tends to occur in colder environments closer to the Cascade crest.

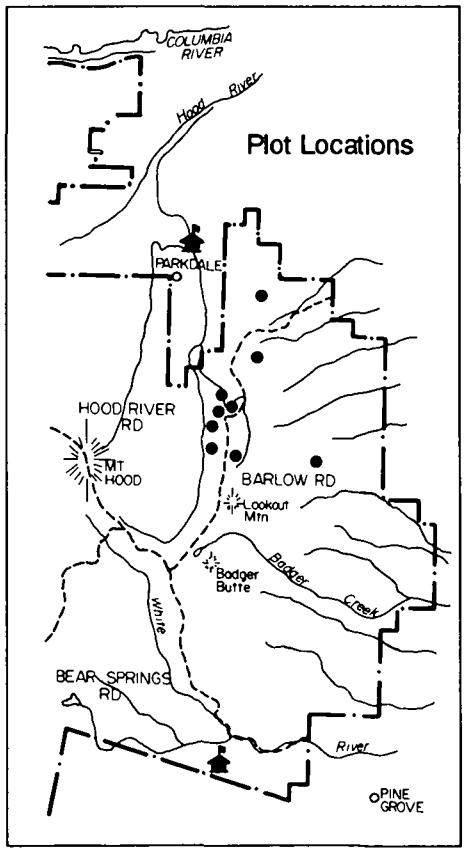
Grand fir/Skunk-leaved Polemonium
Abies grandis/Polemonium pulcherrimum
ABGR/POPU CWF5 23

Environment and Distribution

This association is widespread between 3900 and 4800 feet on the Barlow Ranger District and the eastern portion of the Hood River Ranger District, especially near Dog River. Cold, fairly moist climates typify sites with this association. Snow packs may be quite dense and last well into spring. The high precipitation (average 90 inches/year) includes both more rain and snow during winter, as well as more frequent summer thunderstorm showers. Summer drought does occur, but less severely and more briefly than at lower elevations of the grand fir zone. All aspects and slopes are found.

	Range	Average
Elevation (ft):	3960-4780	4374
Precipitation (in/yr):	70-98	90
Slope (%):	12-60	29

Number of Plots:	9 (intensive = 4)
Common Aspects:	Variable
Topographic Positions:	Various slopes



Vegetation: Structure and Composition

Grand fir (ABGR) dominates the mixed conifer stands found in this association. Douglas-fir (PSME) and lodgepole pine (PICO) may also be canopy dominants in the seral stands which establish following wildfire. The conifer mix is further complicated by occasional western larch (LAOC), western white pine (PIMO), ponderosa pine (PIPO), western hemlock (TSHE), Engelmann spruce (PIEN), western redcedar (THPL) and even traces of Pacific silver fir (ABAM). Grand fir seedlings are the dominant regenerating species in mature stands and should dominate climax stands. Trees may be quite large and dense. Several of our plots had grand fir older than 200 years, which is unusual for this species in this area. The shrub layer is very sparse. The herb flora is diverse and in some stands extensive. Skunk-leaved polemonium (POPU) is the diagnostic species even though it covers at most 4 per cent of the ground. Other common herbs are vanillaleaf (ACTR), sidebells pyrola (PYSE), starflower (TRLA2) and starry Solomonseal (SMST). Grasses include traces of Columbia brome (BRVU) and western fescue (FEOC).

Dominant Vegetation

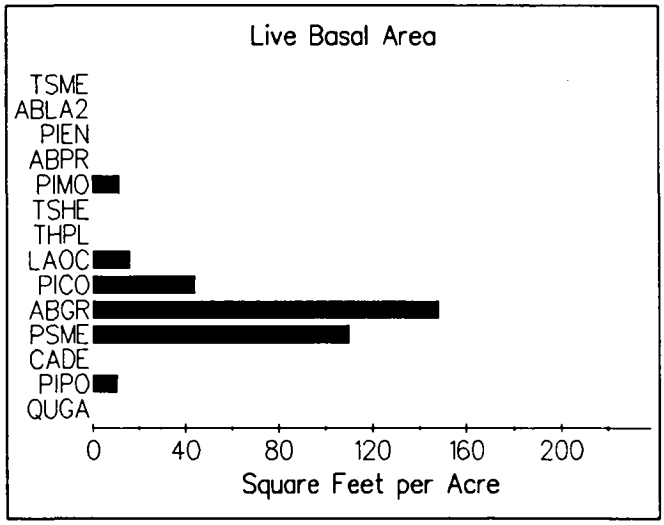
	Code	%Cov	Cons
Overstory Trees			
Grand fir	ABGR	34	100
Douglas-fir	PSME	22	66
Lodgepole pine	PICO	11	55
Western larch	LAOC	3	33
Engelmann spruce	PIEN	3	33
Ponderosa pine	PIPO	3	22
Understory Trees			
Grand fir	ABGR	6	100
Shrubs			
Baldhip rose	ROGY	1	77
Little prince's pine	CHME	1	77
Snowberry	SYMPH	2	44
Oregon boxwood	PAMY	1	44
Forbs			
Skunkleaf polemonium	POPU	2	100
Scouler's bellflower	CASC2	2	88
Sidebells pyrola	PYSE	1	88
Vanillaleaf	ACTR	3	77
Woods strawberry	FRVE	1	55
Starry solomonseal	SMST	2	44
Grasses & Sedges			
Colombia brome	BRVU	2	44
Western fescue	FEOC	1	44

Timber Productivity and Management

Stands in this association have moderate timber productivity. Mature forests are well stocked with grand fir and Douglas-fir. Many of the stems are fairly small grand fir growing up from below. Height growth is moderate. Mixed stands of grand fir, Douglas-fir, Engelmann spruce and western larch will provide maximum site volume growth. Initial stand establishment may be difficult because of the prevailing cold climates. Hence, advance regeneration should be carefully conserved whenever possible. Frost can prevent tree establishment in clearcuts on flat terraces. Grand fir seedlings (planted or advance regeneration) will likely suffer frost damage in clearcuts. Engelmann spruce and western white pine grow well and are sufficiently frost hardy to survive in frost pockets. Protected sites in this association may be planted with noble fir, resulting in stands having high wood quality and good growth. Shelterwoods should naturally regenerate to mixed stands of grand fir and Douglas-fir. Pocket gophers are often abundant on gentle slopes where they damage young plantations.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	107	15.5	263	53.1	9.9	2.8
ABGR	50	76	6.4	346	10.6	13.4	3.3

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
85	14.9	101	31.8	287	35.7	483	24.6



Wildlife and Range

Stands in this association are used by big game for summer grazing but forage is generally poor in abundance and quality. This poor forage may be a result of extensive ungulate utilization of palatable herbs and shrubs. Seeded grass will enhance transitory range only slightly. Cattle forage is at best marginal. Our intensive plots had abundant large snags, but they were all grand fir, a species with low wildlife value and persistence.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
69	4	1	48	15

Fuels Management

Fuel loadings were high on our intensive plots. Conservation of large organic debris plays an important role in efforts to maintain long-term site productivity. Fuels treatments should avoid burning off the protective, nutrient-rich forest floor layers.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
1127	12.0	365	4.7	2.0

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.91	2.83	2.64

Soils

Soil physical properties are very typical for the grand fir zone of the Mt. Hood National Forest. Fine sandy loam surface layers of volcanic ash overlay basalt. Soils are well drained. The high precipitation levels lead to the presence of bleached E (A2) soil surface layers. Heavy machinary can easily compact these ash-dominated soils, particularly when they are moist, drastically reducing long-term site-productivity.

Number of Soil Pits:	5
Effective Soil Depth (cm):	61
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt

Similar Associations

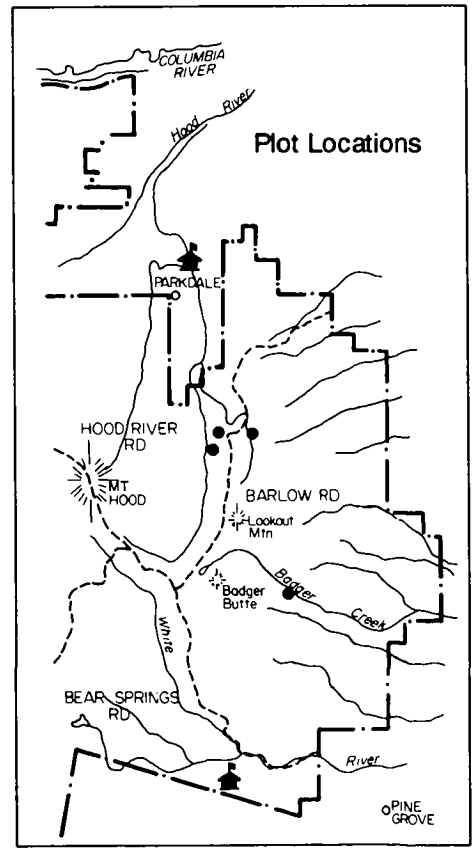
This association is similar to ABGR-PIEN/SMST but the latter has much more Engelmann spruce and total herb cover. ABGR/ACTR, ABGR/LIBO2 and ABGR/TRLA2 can also appear similar but all have less skunk-leaved polemonium and sidebells pyrola. Many of the stands included in the ABGR/PYSE community described for the Badger Allotment, Barlow RD (Williams 1978) are included in ABGR/POPU.

Grand Fir-Engelmann Spruce/Starry Solomonseal
Abies grandis-Picea engelmannii/Smilacina stellata
ABGR-PIEN/SMST **CWC5 11**

Environment and Distribution

This association occurs on moist, cold sites between 4000 and 4500 feet in elevation on the Barlow Ranger District and the eastern portion of the Hood River Ranger District near Dog River. It is not widespread. These sites are at the cold, upper end of the mixed conifer region. Dense snow packs and high rainfall levels shorten summer drought. Precipitation for our plots averaged 85 inches. Sites are usually fairly flat and in protected micropositions. Many stands are in concavities where soil moisture accumulations benefit plant growth. Frost may occur at any time of the year.

	Range	Average
Elevation (ft):	4040-4280	4142
Precipitation (in/yr):	58-98	85
Slope (%):	2-45	17
Number of Plots:	4 (intensive = 3)	
Common Aspects:	Variable	
Topographic Positions:	Flats and slopes	



Vegetation: Structure and Composition

Grand fir, Engelmann spruce and Douglas-fir (PSME) dominate canopies. Other conifers present include lodgepole pine (PICO), western larch (LAOC), and traces of mountain hemlock (TSME), western hemlock (TSHE), Pacific silver fir (ABAM) and ponderosa pine (PIPO). Undisturbed stands are generally well stocked with many large trees and some grand fir saplings growing up from below. Shrub cover is generally sparse except for occasional patches of vine maple (ACCI) or Rocky Mountain maple (ACGLD). We speculate that this is partly due to heavy deer browsing on choice species, such as sitka mountain ash (SOSI). Many mesic and moist-site herb species abound. The more open stands have lush herb carpets, whereas dense, mature stands are dark and have patchy understories. Starry Solomonseal (SMST) is always present. Vanillaleaf (ACTR) or Scouler's bellflower (CASC2) are abundant. The herb layer is very sensitive to light, becoming dense in patches where individual tree deaths cause small gaps in the coniferous canopy.

Dominant Vegetation

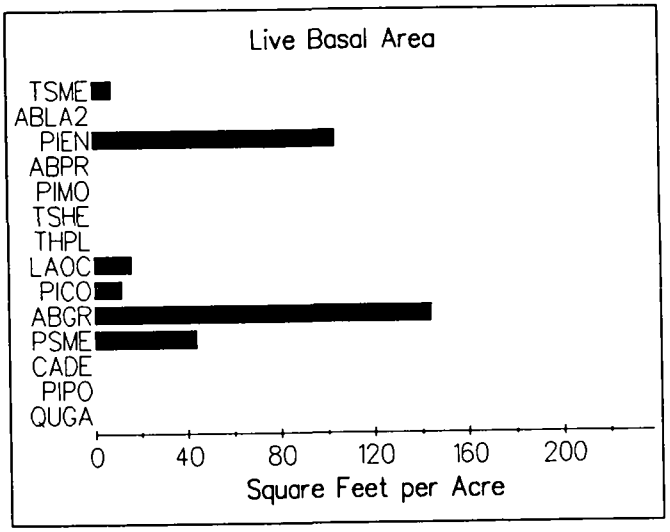
	Code	%Cov	Cons
Overstory Trees			
Grand fir	ABGR	23	100
Engelmann spruce	PIEN	20	100
Douglas-fir	PSME	9	100
Lodgepole pine	PICO	4	50
Understory Trees			
Grand fir	ABGR	7	100
Engelmann spruce	PIEN	2	50
Mountain hemlock	TSME	1	25
Shrubs			
Little prince's pine	CHME	1	75
Snowberry	SYMPH	2	50
Vine maple	ACCI	15	25
Rocky mountain maple	ACGLD	15	25
Forbs			
Vanillaleaf	ACTR	6	100
Starry solomonseal	SMST	2	100
Skunkleaf polemonium	POPU	1	100
Sidebells pyrola	PYSE	2	100
Oregon anemone	ANOR	1	100
Rattlesnake plantain	GOOB	1	100
Scouler's bellflower	CASC2	14	75
Queencup beadlily	CLUN	2	75

Timber Productivity and Management

Once established, trees grow well on sites with this association. Height growth is good (site index, base age 100, averaged 125 for Douglas-fir). Growth basal area values for Douglas-fir (365) and grand fir (352) are among the highest of any grand fir series association. Frost can cause seedling mortality in plantations, especially clearcuts on flat areas. Shelterwood harvests provide a good way to regenerate mixed stands of Douglas-fir, Engelmann spruce and grand fir through natural regeneration. Noble fir should also do well when planted on more protected sites. Engelmann spruce grows well in openings where frost may damage less hardy species. Pocket gophers are common in mature stands and are a constant menace to young plantations throughout this association.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	125	10.1	365	66.6	14.4	1.3
ABGR	50	77	5.0	352	39.2	12.1	0.4

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
113	12.5	154	7.1	351	129	511	32.3



Wildlife and Range

This association includes important summer forage areas for big game. Cattle use is minimal but transitory range following logging can be enhanced by seeding orchardgrass, smooth brome and tall fescue. Many species of wildlife use the dense forests and the large snags common to these forests. The large snags (> 20 in. DBH and 30 ft. tall) on our intensive plots were either Engelmann spruce or ponderosa pine.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
99	2	4	52	41

Fuels Management

Fuel loadings on intensive plots were the highest of any grand fir series association. Because so many sites in this association are fairly flat, machine piling of slash is easily accomplished. However, the long period soils stay moist and their compactability dictates that machine piling be conducted very carefully to minimize soil compaction.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
1860	20.3	153	4.7	2.0

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.69	1.79	2.01

Soils

Soils are generally deep and not stony. The effective soil depth of 86 cm is the deepest of any grand fir series association. Fine sandy loam textured ash surface layers predominate on basalt parent materials. The presence of bleached E (AE) soil horizons is unusual for the grand fir zone and reflects the high precipitation. Soil compaction from heavy machinery is a potential problem because many sites with this association are fairly flat (allowing ready machine access) and they retain substantial moisture well into the summer.

Number of Soil Pits:	3
Effective Soil Depth (cm):	86
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt

Similar Associations

This association is similar to the Grand fir/Skunk-leaved Polemonium Association (ABGR/POPU) but the latter has little Engelmann spruce and generally has lower total herb cover. The Engelmann spruce bottomlands association of the Deschutes National Forest (Volland 1985) and the PIEN/CLUN association for eastern Oregon National Forests (Kovalchik 1987) are fairly similar to this association. The PICEA/CLUN habitat type of Montana is more similar to this association than is the Montana PICEA/SMST habitat type (Pfister and others 1977).

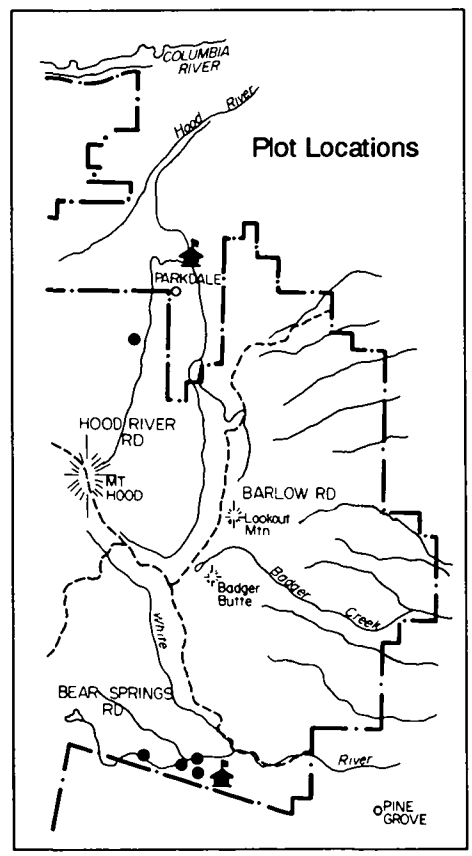
Western hemlock-Grand fir/Queencup Beadlily
Tsuga heterophylla-Abies grandis/Clintonia uniflora
TSHE-ABGR/CLUN CHC3 11

Environment and Distribution

This association occurs at low elevations on the Mt. Hood National Forest east of the Cascade Crest. It occurs on Bear Springs and Hood River Ranger Districts, and on Barlow Ranger District in narrow bands near streams below 3200 feet in elevation. Sites having this association are generally near streams or in places where cool, moist air flows from above. These environments are moderated by the lower solar input found in canyons as well as the greater soil moisture characteristic of lower slope positions. Annual precipitation is high (53) considering the low elevations.

	Range	Average
Elevation (ft):	2600-3300	3080
Precipitation (in/yr):	41-87	53
Slope (%):	2-40	16

Number of Plots:	5 (intensive = 3)
Common Aspects:	Variable
Topographic Positions:	Lower slopes



Vegetation: Structure and Composition

This association includes herb-rich mixed conifer stands having mature and regenerating western hemlock. Canopies are Douglas-fir (PSME) and grand fir (ABGR) dominated. Substantial cover (up to 20%) of western hemlock (TSHE) is common. Other conifers present include western redcedar (THPL), Pacific yew (TABR), western larch (LAOC), and ponderosa pine (PIPO). Our sample plots were more often in older age classes (150 years) than the grand fir series associations. The low wildfire risk is probably caused by the generally moist conditions. Dense understories of dwarf Oregongrape (BENE), vine maple (ACCI) and baldhip rose (ROGY) abound. Creeping snowberry (SYMO) is usually present and may become abundant where ground disturbance has occurred in mature stands. The forb layer is densely populated with a variety of species characteristic of mesic eastside conditions: twinflower (LIBO2), vanillaleaf (ACTR), starry Solomonseal (SMST), and queencup beadlily (CLUN). Other herbs occurring characteristic of moist stands include violets (pioneer (VIGL) and redwoods (VISE)) and dogwood bunchberry (COCA).

Dominant Vegetation

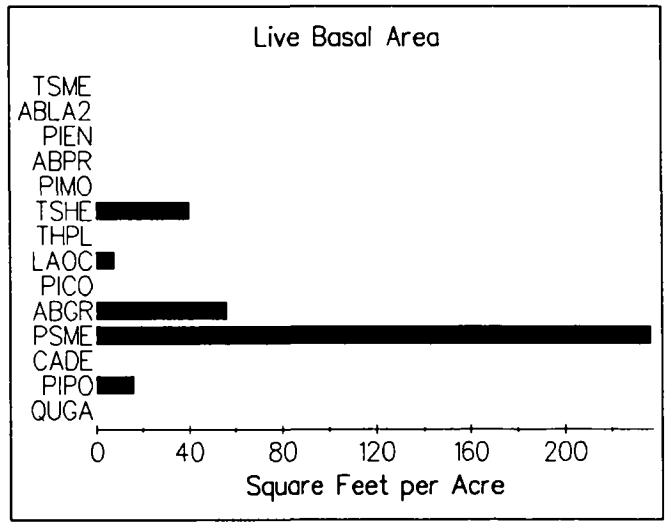
	Code	%Cov	Cons
Overstory Trees			
Douglas-fir	PSME	35	100
Grand fir	ABGR	22	100
Western hemlock	TSHE	15	80
Western redcedar	THPL	10	20
Ponderosa pine	PIPO	3	20
Western larch	LAOC	3	20
Understory Trees			
Grand fir	ABGR	8	80
Western hemlock	TSHE	5	80
Shrubs			
Dwarf oregongrape	BENE	16	100
Vine maple	ACCI	18	80
Prince's pine	CHUM	7	100
Snowberry	SYMPH	4	100
Baldhip rose	ROGY	2	100
Forbs			
Twinflower	LIBO2	14	100
Vanillaleaf	ACTR	8	100
Queencup beadlilly	CLUN	6	80
Starry solomonseal	SMST	2	100
Rattlesnake plaintain	GOOB	1	100
Star-flower	TRLA2	2	80
Sidebells pyrola	PYSE	1	80

Timber Productivity and Management

Timber productivity in this association is moderate. Both height growth and stocking are about the same as the grand fir series associations. Average stand diameter on intensive plots was 18.8 inches, much higher than for grand fir zone associations. Stands are dominated by fairly even-aged, large Douglas-fir with younger grand fir growing up from below. Sites in this association will respond favorably to both clearcuts and shelterwood harvests. Regeneration of Douglas-fir is appropriate: natural regeneration of Douglas-fir in shelterwoods should commonly be successful if Douglas-fir are left as seed trees. Western larch, though not abundant in natural stands, is an excellent choice as seed trees in shelterwoods. A possible limitation to the use of clearcuts is the common occurrence of this association adjacent to riparian areas and in critical big game migration routes.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	113	-	224	-	2.0	-
PSME	100	106	8.2	295	21.4	7.3	0.2
ABGR	50	68	-	289	-	8.0	-

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
97	6.2	110	7.2	181	38.9	462	31.2



Wildlife and Range

Stands in this association offer excellent thermal cover and abundant browse and forage for big game. Large snags, providing excellent cavity nesting habitat, are common because of the characteristic good tree growth and low wildfire risk. Yet, most of the large snags (> 20 in. DBH) on intensive plots were grand fir, a species with low wildlife value and persistence. Many sites with this association provide key habitats linking winter range with summer foraging areas. Transitory range for both wildlife and cattle are excellent. Grasses, such as orchardgrass or smooth brome, seeded on disturbed soils will grow well so light seeding (2 lbs./acre) is appropriate. Competition for moisture between seeded grass and young conifers should generally not be severe. Pocket gophers will likely be abundant in plantations where slopes are gentle (< 30%).

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
44	3	4	19	17

Fuels Management

Fuel loadings on our intensive plots were more than twice as high as those measured in any grand fir series association. The majority of this extra woody material is large logs. This heavy loading results from the lack of wildfires characteristic for sites comprising this association. The abundance of large material provides important habitat for many animals which is usually not far from streams. Various fuels treatments can be implemented without eliminating this valuable, large woody debris.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
3685	35.7	508	29.3	51.3

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.52	0.96	2.52

Soils

Soil moisture regimes are strongly affected by the lower slope positions and shaded microsites characteristic of this association. Physical properties are typical for this area, dominated by fine sandy loam textured surface layers of volcanic ash or breccia on basalt parent materials. Soil compaction occurs readily, especially because soils remain moist longer than most eastside locales.

Number of Soil Pits:	4
Effective Soil Depth (cm):	53
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Breccia on basalt, or ash on basalt

Similar Associations

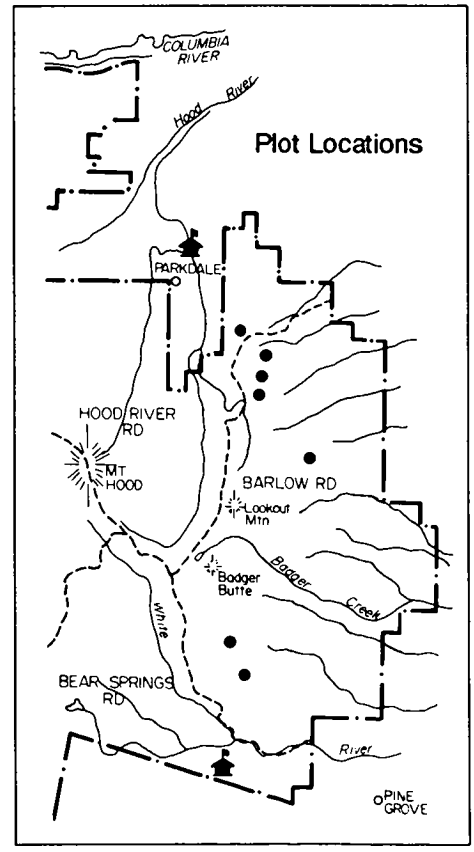
Stand structure and floristics are fairly similar to associations found west of the Cascade crest (such as TSHE/BENE), except for the abundance of grand fir and some characteristic eastside understory species (eg. creeping hollygrape (BERE) and Oregon anemone (ANOR)). Except for having much more grand fir, this association is similar to both TSHE/LIBO2, described for the Badger Allotment (Williams 1978), and TSHE/ACCI on Warm Springs Indian Reservation (Marsh 1985). TSHE/CLUN habitat types in Idaho (Cooper and others 1987) and Montana (Pfister and others 1977) are similar to this association.

Western redcedar-Grand fir/Vanillaleaf
Thuja plicata-Abies grandis/Achlys triphylla
THPL-ABGR/ACTR CCF2 11

Environment and Distribution

This association occurs at moderate elevations (3000-3800 feet) near creeks and in shaded, lower slope positions. Our plots are mainly on Barlow Ranger District, but this grouping also exists on Hood River and Bear Springs Ranger Districts. The climate is warm and mesic, precipitation averaging 71 inches per year at our plots. Snow packs accumulate each year and help delay the period of summer soil moisture deficit. All slopes and aspects occur, although we found south aspects only at our higher elevation plot (3800 feet). The moist conditions (for the eastern Cascades) result from the high incident rainfall, the shaded conditions at lower slope positions, and the presence of fairly deep soils.

	Range	Average
Elevation (ft):	3180-3820	3563
Precipitation (in/yr):	53-85	71
Slope (%):	8-47	21
Number of Plots:	7 (intensive = 2)	
Common Aspects:	Variable	



Wildlife and Range

Wildlife values are high in this association because of the thermal protection afforded by dense canopies, the abundance of quality forage, and because these sites are frequently near streams. Transitory range is excellent following timber harvest. Seeded grass, such as orchardgrass or smooth brome, will grow aggressively. Soil moisture should be adequate for young conifers unless the grass is heavily seeded or established before tree planting. Large Douglas-fir snags provide important nesting sites for many wildlife species.

Snags - Number/Acre				
Total/ Acre	20"+ DBH 50'+ Ht	20"+ DBH 30-49' Ht	13-19" DBH 30'+ Ht	10-12" DBH 10'+ Ht
18	6	0	11	0

Fuels Management

Fuel loadings on intensive plots were typical for the eastern Cascades. Various fuels treatments can be implemented. Large woody debris provides especially important wildlife habitat in sites having this association because of their frequent proximity to water courses. Careful use of machine slash-piling is required to avoid soil compaction, which adversely affects long-term site productivity.

Woody Debris > 3" Diameter				
Volume ft^3/acre	Weight ton/acre	Total #/acre	20"+ Dia. #/acre	12-19" Dia. #/acre
1036	12.0	176	0	4.5

Fine Fuels - Tons/Acre		
< 1/4" Diameter	1/4 - 1" Diameter	1.1 - 2.9" Diameter
0.85	3.00	4.72

Soils

Soils are typical for the eastern portion of the Mt. Hood National Forest. Fine sandy loam textured volcanic ash surface layers predominate on basalt parent materials. These soils are compactable, especially when moist. Soil moisture-holding properties are good.

Number of Soil Pits:	6
Effective Soil Depth (cm):	57
Soil Surface Texture:	Fine sandy loam
Parent Materials:	Ash on basalt

Similar Associations

This association is similar to ABGR/ACTR but is restricted to shaded lower slopes, usually near creeks. It occurs at much lower elevations than ABGR-PIEN/SMST, and has more western redcedar and much less western hemlock than TSHE-ABGR/CLUN. The THPL/LIBO2 community previously described on the Badger Allotment, Barlow RD, is very similar (Williams 1978). THPL/CLUN habitat types described in Idaho (Cooper and others 1987) and Montana (Pfister and others 1977) are slightly similar to this association.

Vegetation: Structure and Composition

This association includes herb-rich mixed conifer stands having fairly low shrub cover. Either grand fir (ABGR) or Douglas-fir (PSME) dominate canopies. Western redcedar (THPL) is diagnostic for this association; its cover varies from a minor to major canopy constituent. It and grand fir are the most abundant seedling species. Other conifers present in small amounts are western larch (LAOC), western hemlock (TSHE), western white pine (PIMO), noble fir (ABPR), subalpine fir (ABLA2), and Engelmann spruce (PIEN). Ponderosa pine (PIPO) is nearly absent, although it may appear in an early seral role. Shrubs are not abundant. The common occurrence of bigleaf huckleberry (VAME) suggests cool, mesic conditions. Forbs dominate the understory. Most abundant are vanillaleaf (ACTR), twinflower (LIBO2), starry Solomonseal (SMST) and starflower (TRLA2). Dark-forest species are very abundant, including sidebells and whitevein pyrola (PYSE and PYPI), rattlesnake plantain (GOOB), and little and tall prince's pine (CHME and CHUM). Grasses are nearly absent.

Dominant Vegetation

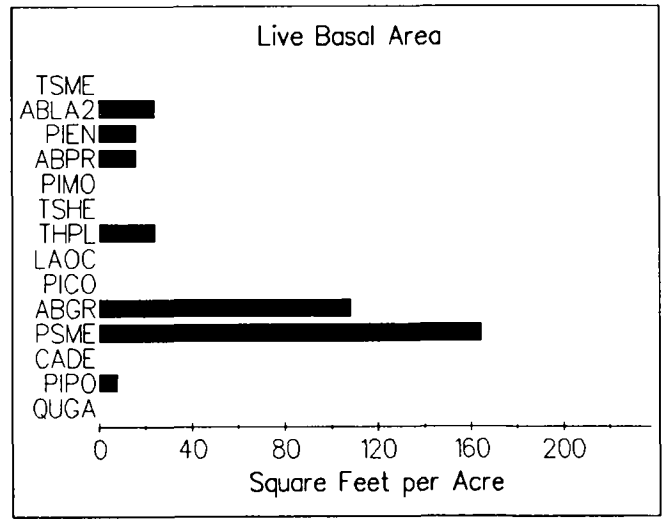
	Code	%Cov	Cons
Overstory Trees			
Grand fir	ABGR	32	100
Douglas-fir	PSME	22	100
Western redcedar	THPL	10	100
Western hemlock	TSHE	5	71
Western white pine	PIMO	11	42
Western larch	LAOC	3	42
Engelmann spruce	PIEN	1	42
Noble fir	ABPR	7	14
Understory Trees			
Western redcedar	THPL	5	85
Grand fir	ABGR	4	85
Western hemlock	TSHE	4	57
Shrubs			
Baldhip rose	ROGY	2	85
White spirea	SPBE	2	85
Snowberry	SYMPH	2	71
Dwarf oregongrape	BENE	1	71
Big huckleberry	VAME	1	71
Thimbleberry	RUPA	1	57
Forbs			
Vanillaleaf	ACTR	4	85
Twinflower	LIBO2	5	85
Star-flower	TRLA2	2	100
Starry solomonseal	SMST	2	85

Timber Productivity and Management

This association has moderate to good timber productivity. Stand stocking varies considerably, although live basal areas are usually high. Douglas-fir grow well; average site index (base age 100) on intensive plots was 119. Overall stand volume growth is enhanced by species mixtures which includes appreciable productivity of grand fir and western redcedar. The mesic environment typical for this association allows many timber harvest options. Clearcuts are easily regenerated with Douglas-fir and western larch. Shelterwoods should result in a greater species mix in future stands. Possible limitations to harvest activities result from the general proximity of sites with this association to streams and big-game migration trails. Pocket gophers may often destroy seedlings, especially on gentle sloped sites (< 30%).

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	108	21.5	308	68.4	10.4	5.6

Yield Capacity $ft^3/ac/yr$		SDI Growth Estimate $ft^3/ac/yr$		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
107	-	142	-	162	-	491	-



Literature Cited

Barnes, G.H. 1962. Yield of even-aged stands of western hemlock. USDA Tech. Bull. No. 1273. 52pp.

Barrett, J. W. 1978. Height growth and site index curves for managed, even-aged stands of ponderosa pine in the Pacific Northwest. Res. pap. PNW-232. Pac. Northwest For. and Range Expt. Station, Portland OR.

Bela, J. L. 1982. Geologic and neotectonic evaluation of North-central Oregon: The Dalles 1 deg X 2 deg quadrangle. Or. State Dept. of Geology and Minerals, Salem, OR

Brady, N. C. 1984. The Nature and Properties of Soils. Ninth ed. Cornell Univ. and US A. I. D.; McMillan Pub. Co., N.Y.

Brickell, J.E. 1970. Equations and computer subroutines for estimating site quality of eight rocky mountain species. USDA Forest Service Res. Pap. INT-75, Intermountain Forest and Range Experiment STation, Ogden, Utah.

Brown, J.K. 1974. Handbook for inventorying downed woody material. USDA Forest Service Gen. Tech. Rep. INT-16. Intermountain Forest and Range Experiment Station, Ogden, Utah.

Coblentz, 1980. Production of Oregon white oak acorns in the Willamette Valley, Oregon. Wildlife Soc. Bull. 8:348-350.

Cochran, P. H. 1979. Site index and height growth curves for managed, even-aged stands of white or grand fir east of the Cascades in Oregon and Washington. Res. pap. PNW-252. Pac. Northwest For. and Range Expt. Station, Portland OR.

Cochran, P.H. 1985. Site index, height growth, normal yields and stocking curves for larch in Oregon. USDA For. Service Res. Paper PNW-424, Pacific Northwest Forest and Range Experiment Station, Portland, Or.

Cooper, S.V., K.E. Neiman, R. Steele, and D.W. Roberts. 1987. Forest habitat types of Northern Idaho: A second approximation. Gen. Tech. Rep. INT-236. Ogden, UT: USDA-Forest Service Intermountain Research Station. 135 p.

Crawford, J.A. and R.S. Lutz. 1984. Merriam's wild turkey habitat use and movements. Oregon Dept. Fish and Wildl. Final Rep. PR-W-79-R-2. 39pp.

Curtis, R. O., F. R. Herman and D. J. DeMars. 1974. Height growth and site index for Douglas-fir in high elevation forests of Oregon-Washington Cascades. Forest Sci. 20:307-316.

Dahms, W.G. 1975, Gross yield of central Oregon lodgepole pine. IN: Baumgartner, D.M. (ed.), Management of Lodgepole pine ecosystems: Proceedings of a Symposium. Pullman, Wa. Wash. St. Univ. Vol 1, 208-232.

Daubenmire, R. 1968. Plant Communities: A Textbook of Plant Synecology. Harper and Row, New York, NY.

Deeming, J.E., R.E. Burgan and J.D. Cohen. 1977. The National fire-danger rating system - 1978. USDA Forest Service Gen. Tech. Rep. INT-39. Intermountain Forest and Range Experiment Station, Ogden, Utah.

Franklin, J. F. and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service General Tech. Report PNW-8, Pac. Northwest For. and Range Expt. Station, Portland OR.

Franklin, J.F. and R.T.T. Forman. 1987. Creating landscape patterns by forest cutting: Ecological consequences and principles. Landscape Ecol. 1:5-18.

Garrison, G. A., J. M. Skovlin, C. E. Poulton, and A. H. Winward. 1976. Northwest plant names and symbols for ecosystem inventory and analysis. Fourth ed. USDA Forest Service Gen. Tech. Rep. PNW-46. Pac. Northwest For. and Range Expt. Station, Portland OR.

Gauch, H.G. Jr. 1977. Ordiflex. A flexible computer program for four ordination techniques. (plus amendments) Ecology and Systematics, Cornell University, Ithaca, New York.

Gauch, H.G. Jr. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press, New York. 298 pp.

Hall, F. C. 1973. Plant communities of the Blue Mountains in eastern Oregon and Southeastern Washington. USDA-Forest Service Area Guide 3-1. Pac. NW Region, Portland, OR.

Hall, F. C. 1984. Ecoclass coding system for Pacific Northwest plant associations. USDA Forest Service R6-ECOL-173-1984. Pacific Northwest Region, Portland, Or.

Hall, F. C. 1988. Growth basal area handbook. USDA Forest Service R6-ECOL-181-b-1985. Pacific Northwest Region, Portland, Or.

Halverson, N.M., C. Topik and R. Van Vickle. 1986. Plant association and management guide for the western hemlock zone, Mt. Hood National Forest. USDA Forest Service Area Guide R6-ECOL-232A-1986. Pac. Northwest Region, Portland, OR. 111 pp

Harvey, A.E., M.F. Jurgensen, and M.J. Larsen. 1979. Role of forest fuels in the biology and management of soil. USDA Forest Service Gen. Tech. Rep. INT-65. Intermountain Forest and Range Experiment Station, Ogden, Utah

Harvey, A.E., M.F. Jurgensen, M.J. Larsen and R. T. Graham. 1987. Decaying organic materials and soil quality in the Inland Northwest: A management opportunity. USDA Forest Service Gen. Tech. Rep. INT-225. Intermountain Forest and Range Experiment Station, Ogden, Utah.

Hemstrom, M.A., W.H. Emmingham, N.M. Halverson, S.E. Logan and C. Topik. 1982. Plant Association and Management Guide for the Pacific Silver Fir Zone, Mt. Hood and Willamette National Forests. USDA Forest Service Area Guide R6-ECOL-100-1982a and 1982b. Pac. NW Region, Portland, OR. 104 pp and 92 pp.

Hopkins, W. E. and R. C. Rawlings. 1985. Major indicator shrubs and herbs on National Forests of eastern Oregon. USDA-Forest Service, Pac. Northwest Region, R6-TM-190-1985.

Kovalchik, B. L. 1987. Riparian zone associations. Deschutes, Ochoco, Fremont, and Winema National Forests. USDA-Forest Service Area Guide R6-ECOL-TP-279-87. Pac. NW Region, Portland, OR. 171 PP.

Lande, R. 1988. Genetics and Demography in Biological Conservation. Science 241:1455-1460.

Lutz, R.S. 1983. Phantom of the Forest. A biologist looks at the Merriam's turkey in Oregon. Oregon Wildlife 38(4):3-6

Lutz, R.S. 1987. Selected life history aspects and habitat use by Merriam's wild turkeys in Oregon. Ph.D. dissertation, Wildlife Science, Oregon State University. Corvallis, Oregon. 52pgs.

Lutz, R.S. and J.A. Crawford. 1987. Seasonal use of roost sites by Merriam's wild turkey hens and hen-poult flocks in Oregon. Northwest Sci. 61:174-178.

Marsh, Frank. 1985. Preliminary plant association guide for commercial forests of Warm Springs Indian Reservation. Manuscript.

Maser, C., R.G. Anderson, K. Cromack, Jr., J.T. Williams, and R.E. Martin. 1979. Dead and down woody material. Ch. 6 IN Thomas, J.W. (tech. ed.), Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. Agric. Handbook 553. Washington D.C.

Maser, C. and J. M. Trappe (tech. eds.). 1984. The seen and unseen world of the fallen tree. USDA Forest Service Gen. Tech. Rep. PNW-164. Pac. NW Forest and Range Expt. Station, Portland Or.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons. New York, N.Y.

Pfister, R. D., B.L. Kovalchik, S.F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. Gen. Tech. Rep. INT-34. Ogden, UT. USDA-Forest Service Intermountain Forest and Range Experiment Station. 174 p.

Reineke, L.H. 1933. Perfecting a stand-density index for even-aged forests. J. Agric. Res. 46:627-638.

Seidel, K.W. and P.H. Cochran. 1981. Silviculture of mixed conifer forests in eastern Oregon and

Washington. USDA Forest Service Gen. Tech. Rep. PNW-121. Pacific Northwest Forest and Range Experiment Station, Portland, Or.

Soil Survey Staff (compilers). 1975. Soil Taxonomy. USDA Soil Conservation Service Agric. Handbook # 436.

Steele, R., R.D. Pfister, R.A. Ryker, and J.A. Kittams. 1981. Forest habitat types of central Idaho. Gen. Tech. Rep. INT-114. Ogden, UT. USDA-Forest Service Intermountain Forest and Range Experiment Station. 138 p.

Stieneckeer, W. and B.M. Browning. 1970. Food habits of the western gray squirrel. Calif. Fish and Game 56:36-48.

Teipner, C.L., E.O. Garton and L.Nelson, Jr. 1983. Pocket gophers in forest ecosystems. Gen. Tech. Rep. INT-154. Ogden, UT. USDA-Forest Service Intermountain Forest and Range Experiment Station. 53 p.

Tansley, A.G. 1935. The use and abuse of vegetational concepts and terms. Ecology 16:284-307.

Thomas, J.W. (tech. ed.) 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. USDA Forest Service Agric. Handbook 553. Washington D.C. 512 pgs.

Thomas, J.W., R.G. Anderson, C. Maser and E.L. Bull. 1979. Snags. Ch. 5 IN Thomas, J.W. (tech. ed.), Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. Agric. Handbook 553. Washington D.C.

Thomas, J.W., C. Maser and J.E. Rodiek. 1979. Edges. Ch. 4 IN Thomas, J.W. (tech. ed.), Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. Agric. Handbook 553. Washington D.C.

Volland, L. and M. Connelly. 1978. Computer analysis of ecological data: methods and programs. USDA Forest Service. Pac. NW Region. Pub. No. R6-ECOL-79-003. Portland, Or 382 pp.

Volland, L. 1985. Plant associations of the Central Oregon pumice zone. USDA-Forest Service Region 6 Area Guide R6-Ecol-104-1985. 138p.

Williams, C. K. 1978. Vegetation classification for the Badger Allotment, Mt. Hood National Forest. Ph. D. dissertation in Rangeland Resources Program, Oregon State Univ., Corvallis OR. 140 p.

Williams, C.K. and T.R. Lillybridge. 1983. Forested plant associations of the Okanogan National Forest. USDA-Forest Service Area Guide R6-ECOL-132a-1983. Pacific NW Region, Portland, OR. 140 p.

Appendix One

Canopy cover of main plant species by association

Percent cover is the average foliar cover for each species in each association calculated only for those plots where the species was present (zero cover values are excluded from the calculations).

Constancy is the percent of plots within an association having that species present.

Species are grouped by life form: Overstory trees, Understory trees, Shrubs, Forbs, Grasses and Sedges.

	PIPO-QUGA/BASA		PIPO-QUGA/PUTR		PSME/CAGE		PSME/FEOC		PSME/HODI/CAGE		PSME/ARNE	
# PLOTS:	6		9		15		8		6		2	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
Overstory Trees												
ABAM	0		0		0		0		0		0	
ABGR	0		0		2	40	2	12	2	33	2	50
ABLA2	0		0		0		0		0		0	
ABPR	0		0		0		0		0		0	
ACMA	0		0		0		0		0		0	
LAOC	0		0		2	6	0		0		0	
PICO	0		0		0		0		0		0	
PIEN	0		0		0		0		0		0	
PIMO	0		0		0		0		0		0	
PIPO	30	100	19	100	11	93	13	100	18	100	34	100
PSME	9	33	6	44	42	86	38	100	33	100	4	100
QUGA	12	83	8	88	10	66	3	75	6	33	0	
THPL	0		0		0		0		0		0	
TSHE	0		0		0		0		0		0	
TSME	0		0		0		0		0		0	
Understory Trees												
ABAM	0		0		0		0		0		0	
ABGR	0		0		2	40	1	37	1	33	3	100
ABLA2	0		0		0		0		0		0	
PIEN	0		0		0		0		0		0	
PIPO	4	66	8	55	1	13	3	25	2	33	2	100
PSME	2	33	2	44	3	73	4	87	5	66	6	100
QUGA	2	66	6	100	2	26	1	62	2	66	0	
THPL	0		0		0		0		0		0	
TSHE	0		0		0		0		0		0	
TSME	0		0		0		0		0		0	
Shrubs												
ACCI	0		0		0		0		0		0	
ACGLD	0		0		10	6	0		1	16	0	
AMAL	2	16	1	33	2	46	4	75	2	100	0	
ARNE	0		0		0		1	12	0		38	100
ARPA	0		10	11	1	6	0		0		1	100
BEAQ	0		0		2	13	4	50	1	66	1	50
BENE	0		0		1	6	0		0		0	
BERE	1	16	1	22	2	53	1	37	1	50	0	
CACH	0		0		0		0		1	16	2	100
CEIN	2	33	1	11	1	20	0		0		0	
CEPR	1	50	1	22	1	6	1	12	0		0	
CEVE	0		0		0		0		0		0	
CHME	0		0		1	6	1	12	1	33	0	
CHUM	0		0		1	6	1	12	0		1	50
CHNA	0		1	11	0		0		0		0	
COCO2	0		0		2	13	2	25	2	83	0	
CONU	0		0		0		0		0		0	
HODI	0		1	11	1	13	1	25	3	100	1	50
LOCI	0		0		2	13	1	25	0		0	
PAMY	0		0		0		0		0		1	50
PUTR	1	33	9	100	1	6	0		0		0	
RIVI	0		0		0		0		0		0	

Appendix One (cont.)

	PIPO-QUGA/BASA		PIPO-QUGA/PUTR		PSME/CAGE		PSME/FEOC		PSME/HODI/CAGE		PSME/ARNE	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
ROGY	1	16	1	22	2	26	1	37	1	66	1	50
RONU	0		1	11	1	6	0		1	16	0	
RULA	0		0		0		0		0		0	
RUPA	0		0		0		0		0		0	
RUUR	0		0		0		0		1	16	0	
SASC	0		0		0		0		0		0	
SOSI	0		0		0		0		0		0	
SPBE	0		0		10	6	3	25	1	50	2	50
SYAL	1	33	2	44	3	60	4	75	8	83	0	
SYMO	1	16	0		4	26	2	25	10	50	1	50
SYMPH	1	50	2	44	3	80	3	100	14	83	1	50
VAME	0		0		0		0		0		0	
Forbs												
ACMI	2	100	3	100	2	40	1	37	1	33	1	100
ACTR	0		0		0		0		0		0	
ADBI	0		0		0		0		0		0	
ANDE	0		0		0		0		0		0	
ANOR	0		0		2	13	2	12	1	33	0	
APAN	0		0		1	20	1	25	1	33	1	50
ARDI	0		0		3	13	1	12	2	16	0	
ARLA	0		0		0		0		0		0	
ARMA3	0		1	11	2	33	1	62	6	83	0	
BASA	3	83	7	33	1	13	0		1	50	0	
CASC2	0		0		0		1	12	0		0	
CLRH	1	16	1	22	0		1	12	0		0	
CLUN	0		0		0		0		0		0	
COCA	0		0		0		0		0		0	
COGR	1	16	1	11	0		1	25	0		0	
DENU3	1	33	1	44	1	6	1	12	0		0	
DIHO	0		0		0		0		0		0	
FRLA	0		0		0		0		1	16	0	
FRPU	1	16	1	11	0		0		0		0	
FRVE	3	33	2	44	2	67	1	75	3	66	0	
GAAP	0		0		0		1	25	0		0	
GATR	0		0		0		0		0		0	
GOOB	0		0		1	6	1	12	1	33	0	
HIAL	1	16	1	11	2	20	2	25	1	66	1	50
HIAL2	2	83	1	100	1	66	2	50	1	33	0	
HYCA	3	33	2	22	1	6	0		0		0	
LALA2	4	33	1	33	1	33	1	12	1	16	0	
LANE	0		1	22	2	13	2	25	4	66	0	
LAPO	0		0		0		0		0		0	
LIBO2	0		0		0		0		0		0	
LIGL	3	66	3	77	2	60	1	62	0		0	
LOMA	0		1	11	2	13	0		1	16	0	
LOTR	2	83	2	44	2	33	1	12	0		0	
LUCA	5	100	3	55	6	46	1	12	1	16	0	
LULE	1	33	2	11	0		0		0		0	
LUNA2	2	16	3	22	1	6	1	12	0		0	
MOPE	1	33	1	44	2	26	1	62	1	16	0	
NEPA	0		3	11	1	6	1	25	0		0	
OSMOR	2	50	1	22	2	66	1	75	1	83	0	

Appendix One (cont.)

	PIPO-QUGA/BASA		PIPO-QUGA/PUTR		PSME/CAGE		PSME/FEOC		PSME/HODI/CAGE		PSME/ARNE	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
PEEU	0		0		1	6	0		1	33	0	
POPU	0		0		0		0		0		0	
PTAQ	0		0		1	6	0		0		2	50
PYPI	0		0		2	6	1	12	0		0	
PYSE	0		0		0		0		0		0	
SADO	0		0		0		0		1	33	0	
SEST	1	16	2	11	2	13	0		1	16	0	
SMRA	0		2	11	2	6	0		0		0	
SMST	0		0		0		0		0		0	
TRLA2	0		0		1	6	1	37	2	100	0	
TROV	0		0		0		0		0		0	
VASI	0		0		0		0		0		0	
VIAM	2	83	3	77	3	13	1	12	1	33	0	
VIGL	0		0		0		0		0		0	
VISE	0		0		0		0		0		0	
Grasses & Sedges												
AGSP	25	16	1	33	3	13	0		0		0	
BRCA	0		7	44	1	20	1	25	2	50	0	
BRTE	3	16	3	33	0		0		0		0	
BRVU	0		0		2	20	1	37	1	50	0	
CAGE	3	33	2	22	25	100	3	75	20	100	1	50
CARU	0		0		16	13	0		4	33	2	50
ELGL	1	33	1	11	2	13	2	37	1	16	0	
FEID	10	50	3	55	10	46	11	25	0		0	
FEOC	0		3	33	17	26	17	100	2	66	3	50
KOCR	4	50	3	77	2	6	1	12	1	16	0	
MEBU	0		0		2	20	2	37	0		0	
POBU	0		1	22	1	6	0		0		0	
PONE	0		0		2	20	2	12	0		0	
SIHY	0		1	33	1	13	0		0		0	
STOC	0		2	11	0		0		0		1	50

Appendix One (cont.)

	PSME/ SYAL		ABGR/ CAGE		ABGR/ HODI		ABGR/ SYMPH		ABGR/ TRLA2		ABGR/ LIBO2		ABGR/ ACCI/ ACTR	
# PLOTS:	6		11		13		24		16		7		10	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
Overstory Trees														
ABAM	0		0		0		0		0		0		0	
ABGR	3	33	7	100	9	100	23	100	33	100	24	100	26	100
ABLA2	0		0		0		0		0		0		0	
ABPR	0		0		0		0		0		0		0	
ACMA	0		0		4	7	0		0		0		3	10
LAOC	0		0		5	7	5	8	5	25	3	71	2	10
PICO	0		0		2	7	0		0		12	57	0	
PIEN	0		0		0		1	4	3	6	2	28	0	
PIMO	0		0		2	7	0		0		3	42	4	10
PIPO	8	100	7	81	14	84	13	79	11	75	11	42	4	30
PSME	55	100	48	100	44	100	39	100	28	100	21	100	42	100
QUGA	4	66	2	27	1	7	5	8	2	6	0		0	
THPL	0		0		0		0		6	12	2	28	0	
TSHE	0		0		0		0		2	6	4	42	5	10
TSME	0		0		0		0		0		0		0	
Understory Trees														
ABAM	0		0		0		0		0		0		0	
ABGR	2	66	3	90	5	100	4	83	3	87	4	100	4	80
ABLA2	0		0		0		0		0		0		0	
PIEN	0		0		0		0		0		0		0	
PIPO	0		0		1	7	0		0		0		0	
PSME	3	83	2	36	2	38	2	33	9	12	0		1	10
QUGA	0		1	45	0		1	4	0		0		1	10
THPL	0		0		0		0		0		0		0	
TSHE	0		0		0		1	8	2	6	2	28	2	10
TSME	0		0		0		0		0		0		0	
Shrubs														
ACCI	0		3	18	2	7	10	25	19	50	0		12	100
ACGLD	0		3	18	9	30	4	20	4	18	4	71	7	30
AMAL	2	16	1	45	2	61	2	45	1	18	2	42	1	10
ARNE	0		0		1	7	0		0		0		0	
ARPA	0		0		0		0		0		0		0	
BEAQ	2	33	2	81	3	61	2	33	5	12	0		1	20
BENE	0		0		3	7	2	16	2	18	11	42	6	70
BERE	2	50	2	36	2	38	2	37	2	18	2	28	1	10
CACH	0		0		1	15	1	4	2	18	1	14	2	20
CEIN	0		0		0		0		0		0		0	
CEPR	0		0		0		0		0		0		0	
CEVE	0		0		0		1	4	0		0		0	
CHME	0		1	45	1	46	1	54	1	81	1	100	1	60
CHUM	0		1	9	2	30	2	20	2	50	2	85	1	30
CHNA	0		0		0		0		0		0		10	10
COCO2	0		2	36	5	61	3	33	13	12	0		1	60
CONU	0		1	9	0		2	4	25	6	0		2	20
HODI	3	33	2	63	6	100	2	50	1	18	3	14	2	40
LOCI	0		1	27	1	23	2	20	1	12	1	28	2	30
PAMY	0		1	18	1	30	1	25	1	12	1	85	1	40
PUTR	0		0		0		0		0		0		0	
RIVI	0		0		0		0		0		0		0	

Appendix One (cont.)

	PSME/ SYAL		ABGR/ CAGE		ABGR/ HODI		ABGR/ SYMPH		ABGR/ TRLA2		ABGR/ LIBO2		ABGR/ ACCI/ ACTR	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
ROGY	4	33	1	63	4	92	2	70	1	87	2	100	2	100
RONU	0		0		0		0		0		0		0	
RULA	0		0		0		0		0		0		0	
RUPA	0		0		0		1	8	1	6	1	14	1	30
RUUR	0		0		1	7	1	4	1	6	1	14	1	60
SASC	0		0		0		0		1	12	1	14	0	
SOSI	0		0		0		0		0		0		0	
SPBE	1	16	1	27	2	61	2	20	1	31	11	42	1	30
SYAL	4	100	16	72	16	46	8	70	3	31	1	42	6	20
SYMO	2	16	2	54	9	61	7	50	4	75	8	42	7	90
SYMPH	4	100	15	81	14	92	9	100	4	93	5	85	7	100
VAME	0		0		0		0		0		1	71	0	
Forbs														
ACMI	1	66	1	36	1	15	1	4	0		0		0	
ACTR	0		0		1	15	1	8	1	6	1	85	2	100
ADBI	0		1	9	1	7	1	8	1	12	1	14	1	70
ANDE	0		0		0		0		1	12	1	28	1	40
ANOR	3	33	1	27	2	38	1	50	1	68	1	85	4	30
APAN	0		1	9	1	15	1	8	1	18	0		1	10
ARDI	2	16	0		2	53	2	16	1	43	0		0	
ARLA	0		0		0		1	4	0		0		0	
ARMA3	1	33	2	72	3	76	2	62	2	56	1	57	1	30
BASA	0		2	18	1	7	1	4	0		0		0	
CASC2	2	16	2	27	2	69	2	50	2	75	2	42	1	20
CLRH	0		1	18	1	7	0		0		0		0	
CLUN	0		0		0		1	4	1	6	2	28	0	
COCA	0		0		0		0		0		0		0	
COGR	0		0		0		0		0		0		0	
DENU3	0		0		0		0		0		0		0	
DIHO	0		1	27	1	23	1	20	1	31	0		2	60
FRLA	1	16	1	36	1	15	1	4	0		0		0	
FRPU	0		0		0		0		0		0		0	
FRVE	2	83	2	82	2	92	1	70	1	63	5	71	1	40
GAAP	0		1	27	1	15	1	25	1	18	0		1	20
GATR	0		1	9	0		1	4	1	6	1	42	1	30
GOOB	0		1	36	1	30	1	54	1	56	1	85	1	50
HIAL	0		1	9	1	46	1	45	1	68	1	57	1	50
HIAL2	2	83	2	54	1	30	1	37	0		1	14	0	
HYCA	0		1	18	0		0		0		0		0	
LALA2	1	16	0		0		1	8	0		0		0	
LANE	3	50	1	36	2	30	2	12	2	18	1	14	0	
LAPO	0		0		1	7	0		0		0		2	10
LIBO2	0		0		1	7	3	12	1	43	5	100	6	30
LIGL	2	50	0		0		0		0		0		0	
LOMA	0		0		0		0		0		0		0	
LOTR	0		1	18	1	7	0		0		0		0	
LUCA	3	33	3	9	2	23	1	4	1	12	0		0	
LULE	0		0		0		0		0		0		0	
LUNA2	0		1	9	1	7	2	8	0		0		0	
MOPE	2	16	1	36	1	7	1	12	1	6	0		0	
NEPA	0		0		0		1	12	0		0		0	
OSMOR	3	100	2	91	1	69	1	79	1	37	1	28	1	50

	PSME/ SYAL		ABGR/ CAGE		ABGR/ HODI		ABGR/ SYMPH		ABGR/ TRLA2		ABGR/ LIBO2		ABGR/ ACCI/ ACTR	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
PEEU	0		1	9	1	7	0		0		0		0	
POPU	0		0		0		0		0		1	28	1	10
PTAQ	0		6	9	20	7	1	16	1	43	2	14	2	40
PYPI	0		1	9	1	7	1	8	1	50	1	71	1	30
PYSE	0		0		0		1	20	1	43	2	85	1	40
SADO	0		1	9	1	7	0		1	12	0		0	
SEST	0		0		0		0		0		0		0	
SMRA	0		1	18	2	46	1	20	1	43	1	57	1	50
SMST	0		0		3	7	1	8	1	25	1	71	1	40
TRLA2	1	16	3	54	2	76	2	50	2	100	2	85	4	100
TROV	0		1	18	1	38	1	29	1	68	1	71	1	60
VASI	0		0		0		0		0		0		0	
VIAM	2	33	2	18	1	23	0		0		0		0	
VIGL	0		0		0		0		0		1	14	0	
VISE	0		0		0		0		0		0		1	10
Grasses & Sedges														
AGSP	0		1	9	0		0		0		0		0	
BRCA	0		1	9	0		0		0		0		0	
BRTE	0		0		0		0		0		0		0	
BRVU	0		6	45	1	61	1	25	1	6	0		1	30
CAGE	1	16	24	100	4	61	2	29	1	25	1	14	0	
CARU	0		1	9	2	15	1	4	0		0		0	
ELGL	0		1	27	0		0		0		0		0	
FEID	1	50	1	45	1	7	2	25	0		1	14	0	
FEOC	1	50	4	72	2	69	1	41	1	43	1	28	1	20
KOCR	2	16	1	9	1	7	0		0		0		0	
MEBU	2	33	2	36	1	7	1	25	0		1	14	0	
POBU	0		0		0		0		0		0		0	
PONE	0		1	9	0		0		0		0		0	
SIHY	0		0		0		0		0		0		0	
STOC	0		0		0		0		0		0		0	

Appendix One (cont.)

	ABGR/ ACTR		ABGR/ CACH		ABGR/ POPU		ABGR-PIEN/ SMST		TSHE-ABGR/ CLUN		THPL-ABGR/ ACTR	
# PLOTS:	10		4		9		4		5		7	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
Overstory Trees												
ABAM	0		0		4	11	3	25	0		0	
ABGR	25	100	10	100	34	100	23	100	22	100	32	100
ABLA2	0		0		0		0		0		0	
ABPR	0		0		0		0		0		7	14
ACMA	0		0		0		0		0		0	
LAOC	2	10	4	50	3	33	15	25	3	20	3	42
PICO	2	20	38	50	11	55	4	50	0		0	
PIEN	0		0		3	33	20	100	0		1	42
PIMO	3	10	1	25	3	11	0		0		11	42
PIPO	2	30	15	25	3	22	2	25	3	20	1	14
PSME	40	100	23	75	22	66	9	100	35	100	22	100
QUGA	0		0		0		0		0		0	
THPL	0		0		1	11	0		10	20	10	100
TSHE	1	10	0		5	11	3	25	15	80	5	71
TSME	0		0		1	11	0		0		0	
Understory Trees												
ABAM	0		0		0		0		0		0	
ABGR	6	90	7	100	6	100	7	100	8	80	4	85
ABLA2	0		0		0		0		0		0	
PIEN	0		0		1	11	2	50	0		1	28
PIPO	0		0		0		0		0		0	
PSME	0		7	75	1	22	0		0		2	14
QUGA	0		0		0		0		0		0	
THPL	0		0		0		0		0		0	
TSHE	1	10	0		1	22	0		5	80	4	57
TSME	0		0		0		1	25	0		0	
Shrubs												
ACCI	2	10	30	25	0		15	25	18	80	0	
ACGLD	3	60	2	25	3	11	15	25	0		2	57
AMAL	2	10	0		2	11	0		1	40	0	
ARNE	0		0		0		0		0		0	
ARPA	0		0		0		0		0		0	
BEAQ	1	40	1	25	2	11	0		0		0	
BENE	11	30	8	25	1	22	1	25	16	100	1	71
BERE	1	30	1	50	0		0		1	40	1	14
CACH	1	10	5	100	1	22	0		4	20	0	
CEIN	0		0		0		0		0		0	
CEPR	0		0		0		0		0		0	
CEVE	1	10	0		0		0		0		0	
CHME	1	60	1	50	1	77	1	75	1	20	1	85
CHUM	1	90	4	100	2	44	1	25	7	100	1	85
CHNA	0		0		0		0		0		0	
COCO2	1	20	1	25	0		0		1	20	1	
CONU	0		0		0		0		1	20	0	
HODI	2	50	4	25	2	22	0		0		0	
LOCI	1	30	1	25	1	22	1	25	0		1	14
PAMY	1	60	1	75	1	44	1	50	1	60	2	57
PUTR	0		0		0		0		0		0	

Appendix One (cont.)

	ABGR/ ACTR		ABGR/ CACH		ABGR/ POPU		ABGR-PIEN/ SMST		TSHE-ABGR/ CLUN		THPL-ABGR/ ACTR	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
RIVI	0		0		0		1	25	0		0	
ROGY	2	90	4	100	1	77	3	50	2	100	2	85
RONU	0		0		0		0		0		0	
RULA	0		0		0		1	25	0		0	
RUPA	1	50	0		1	33	1	25	0		1	57
RUUR	1	30	1	25	0		0		1	60	1	14
SASC	0		0		10	11	0		0		0	
SOSI	1	10	1	25	0		1	25	0		1	28
SPBE	2	80	2	50	0		0		1	20	2	85
SYAL	4	40	3	75	1	33	0		2	20	2	28
SYMO	3	60	8	50	2	22	2	50	3	100	2	42
SYMPH	4	90	6	100	2	44	2	50	4	100	2	71
VAME	0		2	25	1	22	0		1	60	1	71
Forbs												
ACMI	0		0		0		0		0		0	
ACTR	7	100	3	75	3	77	6	100	8	100	4	85
ADBI	1	60	3	25	0		3	25	1	60	1	42
ANDE	1	30	3	25	1	33	2	50	1	80	1	42
ANOR	2	40	2	50	1	55	1	100	2	60	2	71
APAN	0		0		0		0		0		0	
ARDI	1	30	1	25	0		0		0		0	
ARLA	0		0		0		0		0		0	
ARMA3	1	90	4	50	2	44	1	50	1	40	1	28
BASA	0		0		0		0		0		0	
CASC2	2	50	1	75	2	88	14	75	1	20	1	14
CLRH	0		0		0		0		0		0	
CLUN	1	10	0		3	22	2	75	6	80	3	42
COCA	0		0		0		0		2	20	1	14
COGR	0		0		0		0		0		0	
DENU3	0		0		0		0		0		0	
DIHO	1	60	0		0		1	25	1	60	1	28
FRLA	0		0		0		0		0		0	
FRPU	0		0		0		0		0		0	
FRVE	1	70	1	75	1	55	2	25	1	60	1	42
GAAP	1	30	0		1	33	0		0		1	42
GATR	1	40	1	25	2	33	1	25	1	40	1	42
GOOB	1	80	1	50	1	33	1	100	1	100	1	100
HIAL	1	80	2	100	1	66	1	50	2	40	1	42
HIAL2	0		1	25	0		0		0		1	14
HYCA	0		0		0		0		0		0	
LALA2	0		0		0		0		0		0	
LANE	1	10	0		0		1	25	1	20	0	
LAPO	0		0		0		0		0		0	
LIBO2	6	40	6	75	4	22	3	25	14	100	5	85
LIGL	0		0		0		0		0		0	
LOMA	0		0		0		0		0		0	
LOTR	0		0		0		0		0		0	
LUCA	0		2	50	0		0		0		0	
LULE	0		0		0		0		0		0	
LUNA2	1	10	0		2	11	1	25	0		0	
MOPE	0		0		0		0		0		0	

Appendix One (cont.)

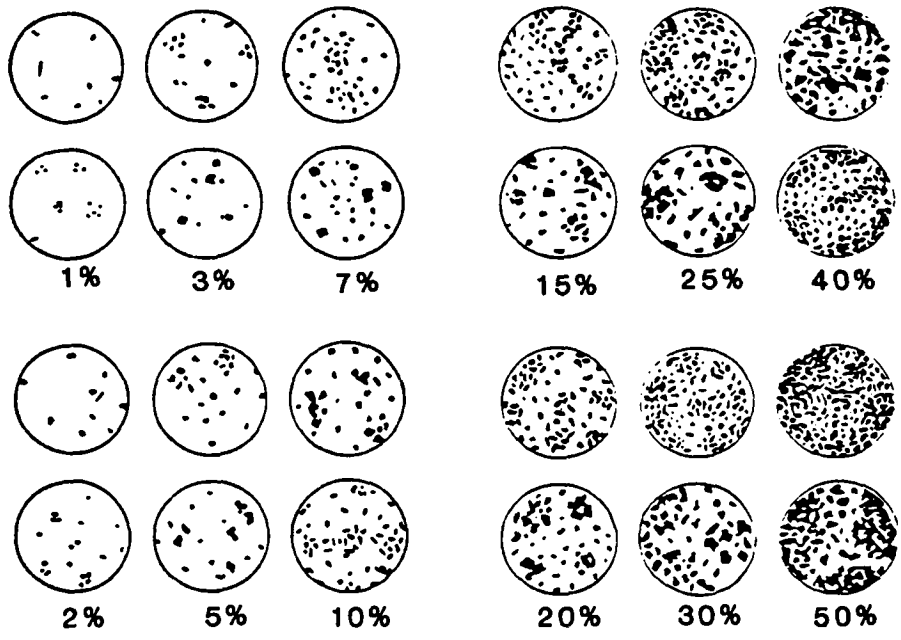
	ABGR/ ACTR		ABGR/ CACH		ABGR/ POPU		ABGR-PIEN/ SMST		TSHE-ABGR/ CLUN		THPL-ABGR/ ACTR	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
NEPA	0		0		0		0		0		0	
OSMOR	1	60	1	75	1	44	1	75	1	60	1	14
PEEU	0		1	25	0		0		0		0	
POPU	1	10	1	25	2	100	1	100	0		1	14
PTAQ	2	50	0		0		3	25	1	20	1	28
PYPI	1	60	1	25	1	33	0		1	40	1	57
PYSE	2	90	3	50	1	88	2	100	1	80	2	100
SADO	1	20	0		0		0		0		0	
SEST	0		0		1	11	0		0		0	
SMRA	1	70	1	75	1	33	0		1	20	1	57
SMST	1	60	0		2	44	2	100	2	100	2	85
TRLA2	3	100	3	50	1	44	3	25	2	80	2	100
TROV	1	90	1	75	1	33	2	25	1	80	1	71
VASI	0		0		1	11	3	50	0		0	
VIAM	0		0		0		1	25	0		0	
VIGL	1	10	0		1	22	1	75	1	60	1	14
VISE	0		0		0		0		1	60	0	
Grasses & Sedges												
AGSP	0		0		0		0		0		0	
BRCA	0		0		0		0		0		0	
BRTE	0		0		0		0		0		0	
BRVU	1	50	0		2	44	1	50	1	40	1	14
CAGE	0		1	50	1	11	0		1	40	0	
CARU	0		0		3	11	0		0		0	
ELGL	0		0		0		0		0		0	
FEID	0		0		0		0		0		0	
FEOC	1	40	1	75	1	44	1	25	1	20	1	14
KOCR	0		0		0		0		0		0	
MEBU	1	10	1	25	1	22	0		0		0	
POBU	0		0		0		0		0		0	
PONE	0		0		0		0		0		0	
SIHY	0		0		0		0		0		0	
STOC	0		0		0		0		0		0	

Appendix Two

Charts used to estimate percent cover of both understory and overstory species.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

COMPARISON CHARTS FOR VISUAL ESTIMATION OF FOLIAGE COVER 1/



1. Developed by Richard D. Terry and George V. Chilingar. Published by the Society of Economic Paleontologist and Minerologist in its Journal of Sedimentary Petrology 25 (3): 229-234, September, 1955.

Acknowledgements

We want to thank the many persons who helped us with background information, field work, reviews and publication production. The authors are responsible for mistakes, but the following persons have greatly aided this publication. Thanks to Dr. Clint Williams for his very helpful Badger allotment plant association work which we have built upon. We thank Dave Gross and Drs. Fred Hall, Len Volland and Charlie Johnson for helping familiarize us to the study area. Excellent field assistance was performed primarily by forester John Haglund and botanist Barbara Fox, with the assistance of Caroline Wright and Dave Gross as well as several other Forest Service employees for brief periods. We thank Len Volland, Frank Marsh, David Tart, Clint Williams, and Terry Lillybridge for reviews of an earlier, incomplete draft. Diana Nead drew the maps, Anna Clark helped with some of the computer graphs, and John Platz drafted Figure 1. Thanks to Rich Fairbanks for providing training on the desktop publisher. Special thanks to John Haglund who executed the publication layout using the Ventura brand desk-top publishing software.

☆ U.S. GOVERNMENT PRINTING OFFICE 1992—693-609